Bright Minds, Big Rent:
Gentrification and the Rising Returns to Skill*†

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Abstract

In 1980, Census data indicate, housing prices in large US cities rose with distance from the city center. By 2010, that relationship had reversed. We propose that this development can be traced to greater labor supply of high-income households which reduced the tolerance for commuting. In a tract-level data set covering the 27 largest US cities, years 1980-2010, we find support for our hypothesis using a Bartik-type demand shifter for skilled labor: full-time skilled workers favor proximity to the city center and their increased presence can account for the rising price premium commanded by centrality.

Keyword: Gentrification; suburbanization; returns to skill; labor supply; location choice.
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I know things will get better
You'll find work and I'll get promoted
We'll move out of the shelter
Buy a bigger house and live in the suburbs

Tracy Chapman, Fast Car, 1988

The truth is that we are living at a moment in which the massive outward migration of the affluent that characterized the second half of the twentieth is coming to an end.

Ehrenhalt, The Great Inversion, 2013

1 Introduction

Deep seated poverty marked US inner cities for most of the post-WWII era. Towards the end of the 20th century, however, the storyline changed. In 1980, 2-3 bedroom homes in major US cities were more expensive outside than inside the 10-mile ring, reflecting the then dominant urban pattern – affluent suburbs alongside inner cities in a seemingly unbreakable tailspin. Fast forward a generation and inner-city real estate has regained its footing. In fact, the price-distance pattern reversed (see Figure 1). The ascendancy of the city center forms the set piece of what is loosely referred to as gentrification. Manifest already in 1990, it has continued unabated since – the 1980s crime wave and the recent housing correction notwithstanding.

Why this sea change? Why has gentrification replaced suburbanization as the urban trend of note? Why is it that demographic groups that formerly would have headed straight to the suburbs now seek to stay in the city, e.g., Couture and Handbury [2015], Baum-Snow and Hartley [2016], Hwang and Lin [forthcoming]?

One possibility is that the higher demand for centrally located housing stems from the growth in the number of high-income individuals, some of whom always favored central-city living [Gyourko et al., 2013]. Between 1970 and 2010, the US population grew by more than 100 million people and the urbanization rate increased from 73 to 81 percent.[1] Greater demand combined with land scarcity results in upward price pressure in the city center. But inelastic supply is not limited to city centers. Many upscale towns effectively limit housing supply by local ordinances and the like [Ortalo-Magne and Prat, 2014], but price increases have been markedly concentrated around city centers (cf. Figure 1).[2]

[1] See Davis and Heathcote [2007] for the rising share of land rent in housing values.

[2] For instance, while real estate prices in Manhattan rose by 33% in the last 10 years, they shrunk in

More congested roads is another “more people” related explanation. Congestion makes commuting more time consuming, less predictable, and less convenient.[3] Glaeser et al. [2008] argued that the concentration of poverty in the central city could be explained by the availability of public transportation, which is cheap but slow compared to commuting by car. Car ownership, higher among the rich, explains why the rich would locate away from the city center. If faced with only one mode of transportation, effectively the case if car travel is not faster than public transportation, then the rich would prefer to locate in the city. However, a number of large US cites actually experienced a population decrease in the last decades (e.g., Detroit) and the ascendancy of the city center evident in Figure 1 holds both for cities that grew and cities that shrank.[4]

The life cycle of real estate may be another factor driving urban trends. If high-income households prefer a younger housing stock, then that could explain why they headed to the newly developed suburbs. The subsequent return to the city could similarly be explained by the arrival of new construction as the old real estate reached the end of its life span [Brueckner and Rosenthal, 2009]. This explanation, however, ignores the extensive renovation and residential conversion of urban real estate that has taken place in the wake of gentrification, e.g., Helms [2003], which suggests that in the US, high-income households have picked their preferred place of residence and then built or renovated existing real estate to their specifications.

Decline in crime is another candidate explanation: high crime rates have been found to contribute to urban flight [Cullen and Levitt, 1999], and it stands to reason that the drastic decline in crime since the early 1990s would have the reverse effect.[5] Ellen and O’Regan [2010] extended Cullen and Levitt’s analysis to cover the 1990s, and thus studied periods of both rising and declining crime. They found only a limited role for crime, consistent with our observation that the price-distance relationship pivoted already in the 1980s, a decade in which violent crime rose [Donohue and Levitt, 2001]. We also note that European cities did not experience a level of crime in their inner cities anywhere near US levels but have nonetheless seen similar, core-centered, urban renewal, e.g., Carpenter and Lees [1995], Boterman et al. [2010]. Taken together, these observations suggest to us that while lower crime has made the central city more livable, the sources of gentrification may be elsewhere.

Yet another strand of the literature has focused on the role of local amenities. For instance,

suburbs such as White Plains and Chappaqua, both affluent towns in the NYC metro area (`http://www.neighborhoodscout.com/`).

[3] The daily commuting time has rise by about eight minutes since 1980 [McKenzie and Rapino, 2011].

[4] See Appendix Figures A1 and A2.

[5] The origins of crime’s rise and fall are debated. A non-exhaustive list includes the removal of school prayers, abortion legalization [Donohue and Levitt, 2001, Foote and Goetz, 2008], more aggressive and targeted policing, greater incarceration rates, electronic surveillance, ATMs and credit cards, the crack epidemic, and environmental factors such as lead exposure [Reyes, 2007].

a concentration of cultural institutions, parks, and monuments boosts the attractiveness of the central city and European cities' advantage in that department may explain why high-income households in Europe did not decamp for the suburbs [Brueckner et al., 1999]. Clearly, this explanation speaks more to the suburbanization phase than the urban revival of late. Furthermore, although the US does not have Paris, it does have New York City. By the end of the 19th century, New York City was the financial and cultural capital of the world's greatest economy, and it shows in the many cultural institutions in place well before the post-war decades of white flight and urban decay.[6]

Time varying amenities are better placed to account for gentrification. A caveat, however, is that such amenities are likely endogenous to the socio-economic characteristics of the local population, e.g., Albouy and Lue [2015]. The "spreading" through space – one location's good amenities boosting the attractiveness of nearby areas, thus attracting a more affluent demographic, which in turn feeds a self enforcing circle – can provide a handle on endogeneity [Guerrieri et al., 2013]. Still, the question of ground zero remains.

In this paper we focus on one local amenity – centrality – a feature which by and large has been fixed.[7] What changed, we argue, is its importance. The roots of this change, we propose, can be found in the greater labor supply of high-income households. For instance, in 1980, some 60 percent of prime working age households[8] at the 80th percentile of the income distribution had at least one householder (spouse or head) who did not work full-time. By 2010, that figure was down by a third (see Figure 2).

Individual labor supply by education paints a similar picture. The share of the college educated who work full time has increased and the increase has been particularly pronounced for college women and for those with advanced degrees. Further, among the skilled, the 50+ hour week (or "long hours," to use the terminology of Kuhn and Lozano [2006]) has become more common (see Figures 3 and 4).[9]

Greater labor supply, we propose, has moved high-income households towards the city center because it affords a shorter commute. The downside is the higher cost of space. However, longer work hours reduces the amount of time available to spend at home, and thus the importance of spacious quarters. Second, for the skilled, longer hours have been accompanied by a reduction in leisure [Aguiar and Hurst, 2009, table 2-2]. Scarce leisure, in turn, may reduce the tolerance

[6] In 1975, New York City came very close to filing for bankruptcy.

[7] Clearly centrality itself is the result of a confluence of factors, but these were largely settled before the current wave of gentrification.

[8] Defined as households where at least one householder (head or spouse) was of prime working age (25-55).

[9] Use of the Current Population Surveys (CPS) allows for finer education categories (but limits the time period). Distinguishing between just college and a graduate degree, the skill-hours gradient still holds. For men, the difference is particularly pronounced at the 50+ hour margin, while for women it is evident also at the 40+ hour margin, Appendix Figures A3 and A4.

for low utility, non-work activities such as commuting.

This story does not deny a role for local amenities in affecting the transformation, but we propose they are amplifiers rather than drivers.[10] Greater purchasing power in high-density areas paves the way for cultural and recreational amenities such as galleries, performance venues, restaurants, and bars, thus strengthening the attractiveness of the city center [Glaeser et al., 2001, Couture and Handbury, 2015].

Longer hours by skilled workers is not a foregone conclusion. Why would the substitution effect dominate the income effect? The answer may lie in the high and rising returns to skill [Katz and Murphy, 1992, Juhn et al., 1993, Autor et al., 2008] ushered in by the Information Technology (IT) revolution [Greenwood and Jovanovic, 1999, Hobijn and Jovanovic, 2001]. Beyond college or graduate school, most skill building takes place on company time and often is in the form of working, an observation consistent with the high rewards associated with long hours, e.g., [Goldin, 2014]. Thus our paper is also related to the growing literature on the spatial and housing market consequences of the IT revolution, e.g., Berry and Glaeser [2005], Beaudry et al. [2010], Moretti [2013], Autor and Dorn [2013].

To investigate the empirical content of our hypothesis, one approach would be to regress housing prices in a locality on the presence of full-time skilled workers in that locality, as well as a battery of controls. However, the weaknesses are obvious. Full-time skilled workers have high incomes. That high-income households also consume more housing (in dollar terms) would be neither surprising nor speak to our hypothesis. The central city could have been more attractive to the high-skill-low-leisure population for reasons unrelated to commuting. For instance, as mentioned, the return of high-income households could be driven by the cultural amenities on offer in the city center, a pendulum swing springing from the real-estate life cycle, or simply a cultural reaction against the ubiquity of subdivisions and cul-de-sacs (e.g., Gallagher [2014]). Reverse causality is also a possibility – higher rents prompting greater labor supply [Johnson, 2012].

Our empirical strategy is to use a Bartik-type demand shifter [Bartik, 1991]. This demand shifter uses a location's employment composition in an appropriately chosen base year and national employment trends excluding the locality in question to generate predicted labor demand. The exclusion of the focal locality allows for the generation of arguably exogenous variation in the demand for full-time skilled labor, which in turn result in housing demand close to those jobs, viz. the city center. Assuming that a city constitutes an integrated labor market, a reasonable local labor demand shifter varies across cities.

Our principal data set draws from restricted use decennial census micro data or the American

[10]Diamond [2016] found that greater city level demand for skilled labor reduced crime.

Community Survey (ACS) and covers the period 1980-2010. With 1970 as the base year for the Bartik shifter, 1980 is our first year of decennial census data. Data availability dictates the last year (2010 short hands for the pooled 5-year ACS sample 2008-2012). We focus on top-20 cities by population size, a list that has not been stable over the study period. We include cities that were in the top-20 in either 1970 or 2010, the case for 27 cities. We aggregate micro-level data to the census tract, and our key dependent variable is the median price for a two- or three-bedroom home in the tract. To measure the presence of full-time skilled workers, we consider two cut offs for full time and skill: 40 or 50 hours per week and a four-year college or advanced degree, respectively.

Our endogenous variable of interest varies at the sub-metro level. Therefore, we interact the city-year demand shifter with the (tract) distance from the central business district (CBD) for a shifter that varies within each city-year. In recognition of the role of the IT revolution in driving spatial variation in demand for skilled labor [Beaudry et al., 2010] we use 1970 as the base year and construct the demand shifter from a combination of 1970 city-level employment and national growth trends, following a number of recent papers, e.g., Diamond [2016], Moretti [2013].

Our baseline specification includes city-year and city-distance fixed effects. City-year fixed effects absorbs any city-wide changes, for instance city-level labor demand shifts or credit expansion,[11] as well as any city fixed effects, such as topography, or climate, or any historically fixed factors such a history of racial tension or pre-existing infrastructure, monuments, or institutions. City-distance fixed effects are similar to tract fixed effects (as a robustness check, we cross walk tracts, which allows us to include tract fixed effects). Our most demanding specification also include distance-year fixed effects, which absorbs any overall changes to the distance-price relationship.

We start by establishing some basic patterns. First, housing prices and the Bartik demand shifter are highly correlated, and the relationship is strongest close to the CBD. Second, we expect the Bartik shifter to raise skilled labor supply, and data confirm this conjecture: we find a strong positive relationship between the Bartik shifter and the fraction of the prime working age population that is skilled and works full-time.

In order to investigate the role of confounders, we look at sub-samples of the data. To check for the role of declining crime we cut the data in two ways: (i) by year, noting that the decline in crime only started in the early 1990s; and (ii) by the extent to which crime declined (cities with high declines and cities with low declines or even increases). Another cut of interest is cities that grew and cities that shrank since 1970. The role of congestion, crowding of high

[11] For recent papers on the role of the latter, see Glaeser et al. [2010], Favara and Imbs [2015].

income individuals, or foreign demand is presumably limited in shrinking cities (viz., Detroit, St. Louis, Cleveland, Baltimore). New York City is unique in many ways (the largest US city, the financial sector, foreign buyers, etc). However, our results are robust to its exclusion. Throughout, we find a strong positive effect of the Bartik demand shifter close to the CBD and a weaker effect thereafter.

It is worth noting that other tract demographics such as race, income, or marital status, moved with the Bartik shifter, and in the expected direction. However, we view these changes as incidental, derived from the primary relationship between the Bartik shifter and the educational and employment status of the tract population.

Turning to the relationship between full-time skilled workers and housing prices, we find empirical support both in OLS and IV regressions, the latter using the Bartik demand shifter. Skilled full-time workers not only locate close to the CBD, their presence raise housing prices. The implied price changes suggest that the growth of skilled full-time workers captures the 1980-2010 housing-price changes well.

Lastly, our argument for the rising salience of centrality rests on the assumption that skilled jobs are predominantly located in the city center and we confirm this to be the case (unskilled jobs, on the other hand, show less geographic concentration, and increasingly so).

The remainder of the paper is organized as follows. We round out this section by sketching the conceptual framework that guides our empirical analysis. Section 2 describes our empirical strategy and the data. Section 3 presents our results. Section 4 concludes.

1.1 Conceptual framework

This sections sketches a theoretical framework to show how the hours worked by the rich can determine whether the city or the suburb is their location of choice, and by extension, whether housing prices rise or fall with distance from the city center. The upshot is that at lower hours the suburb is their location of choice; longer hours and the city is preferred.

Our premise is the canonical mono-centric model of urban development in which commuting time to the suburb is weighted against the lower cost of space [Mieszkowski and Mills, 1993, Rappaport, 2014, 2016]. There are two locations, city and suburb, indicated by subscripts $i = c$ and $i = s$, respectively. All jobs are located in the city whereas both locations can house residential housing stock. Since all jobs are in the city, the suburb comes with a commute. For simplicity we assume that

$$t = \begin{cases} t_s > 0 & \text{if } i = s, \\ 0 & \text{otherwise.} \end{cases}$$

Consider a population of workers, half of whom are skilled and command a high wage w, half of whom are unskilled and command a low wage (we do not need a notation for their wage). For brevity, we will refer to these to groups as rich and poor, respectively. Workers have 16 hours per day at their disposal. Time can be used in three ways: work, h, commuting, t, and leisure, l. To focus on the role of longer hours on location choice, everybody works and we do not allow workers to choose their hours. Furthermore, we assume that the hours for high-wage workers are the same or longer than for low-wage workers. This assumption is in line with stylized facts for the period concerned.[12]

Construction costs are such that only the rich can afford to build durable housing. The poor either live in already built housing or in cheap non-durable housing and for the purpose of this section, housing will refer to the durable type. Housing accumulate as location specific housing stock, $s_i \geq 0, i = c, s$ which rents at $r_i, i = c, s$ (per square foot) whose floor is given by the cost of maintenance. For simplicity, we assume maintenance to be the same in the city and the suburb, $m_c = m_s = m > 0$.[13]

Initially, only the city is developed. If aggregate demand by the rich, s_i^*, at rental price $r_i = m$, exceeds the available housing stock, then housing gets built to meet demand. Land is assumed in infinite supply in the suburb and thus the marginal cost of new construction consists of labor and material, both which are elastically supplied and thus the marginal cost of construction is a constant $c_s > m$. In the city, however, land is scarce and therefore the marginal cost of construction depends positively on the housing stock $c_c(s_c), c_c(0) = c_s > m, c_c'() > 0$.[14]

Rich workers rent $a_i, i = c, s$ square feet at the rental price $r_i, i = c, s$, in either the city or suburb. The rent is

$$r_i = \begin{cases} m & \text{if } s_i^* \leq s_i, \\ c_i & \text{otherwise, } i = c, s \end{cases}$$

where suburban construction cost, c_s, is a constant whereas construction cost in the city, c_c, depends on the housing stock s_c^*.[15]

Workers derive utility from living space, a, leisure, l, and a numeraire consumption good, x. We let utility be of Cobb-Douglas form:

[12] If low wage workers worked longer hours, on the other hand, then it is possible that low wage workers could outbid high wage workers to shorten their commute, but that is not the empirically relevant case.

[13] We allow for housing supply in order to demonstrate robustness to this dose of reality. Qualitatively similar, but amplified, results are obtained if the housing stock is fixed.

[14] For instance, from higher land rent and construction costs.

[15] Strictly speaking, there is an intermediate case where demand at the cost of maintenance exceeds the existing housing stock but demand is not strong enough to elicit new construction. In that case, rent is indeterminate in the range (m, c_i). This does not change our results.

$$u = x^{\alpha} a^{\beta} l^{\gamma},\ \alpha, \beta, \gamma > 0.$$

The monetary and time budget constraints are:

$$x + r_i a_i \leq w\, h,$$

and

$$l = 16 - h - t.$$

The optimization problem may thus be viewed as a two-stage process: first determine which locality would give the highest utility, home size chosen optimally at implied rental price; then pick the location that gives the highest utility. In other words, to pin down the urban location pattern, we need to know where the rich obtain the highest utility: in the city or the suburb? Let a_i^* denote the utility maximizing home size in locality i at the implied rental price. The city gives higher utility if

$$\left(\frac{wh - r_c a_c^*}{wh - r_s a_s^*} \right)^{\alpha} \left(\frac{a_c^*}{a_s^*} \right)^{\beta} > \left(\frac{16 - h - t_s}{16 - h} \right)^{\gamma}. \tag{1}$$

Note that the right hand side of 1 goes to 0 as $h \to 16 - t_s$, whereas the left hand side goes to a positive constant. Thus, there is an $h^* < 16 - t_s$ such that for $h > h^*$, the rich prefer the city.

To determined whether the suburbs could be developed by the rich, we take a further look at the left hand side we see that it has two components: the city to suburb ratio of consumption

$$\frac{wh - r_c a_c^*}{wh - r_s a_s^*} = \frac{x_c^*}{x_s^*} \tag{2}$$

and the city to suburb ratio of optimal housing sizes

$$\frac{a_c^*}{a_s^*}, \tag{3}$$

where

$$a_i^* = \frac{\beta}{(\alpha + \beta)} \frac{wh}{r_i}.$$

If inequality 1 does not hold, then the development of the suburb is preferred. This situation is not guaranteed. However, lower hours (h) helps because it raises the right hand side. Further, a large optimal home size in the suburb relative to the city also helps. Since a_c/a_s varies with the price of construction – a low c_s, for instance from abundance of undeveloped land, clearly favors development of the suburb.

Consider the following three stylized phases of US urban development: (i) the pre-automobile city; (ii) automobile-enabled suburban expansion; and (iii) urban renewal:

Phase (i) Rich and poor live cheek by jowl, the rich in mansions or imposing apartment buildings, the poor in flimsy structures of low durability (cf. tenements). The surrounding land is undeveloped.

Phase (ii) The rich move out to the suburbs where they construct single family homes. The poor stay in the city, occupying the real estate built for the departed rich (or, for realism, public housing).

Phase (iii) The rich move back into the city, spurring new construction and rehabilitation of existing real estate. The poor move to the emptied suburbs.

The role of the automobile in making the transition from Phase (i) to Phase (ii) is widely recognized. In terms of our model, this change would correspond to commuting time going from $t_s \geq 16 - h$ to $t_s < 16 - h$. In Phase (i) rich and poor live in the city, the rich in durable housing and the poor in non-durable housing, the suburb is undeveloped. In Phase (ii) the rich have the option to move to the suburb, which they choose to do if work hours h are low and the houses they can afford to build are sufficiently large to compensate for the commute (a_c^*/a_s^* is low enough). The poor stay in the city in the housing vacated by the rich and pay rent $r_c = m$. Clearly, the square foot rent is higher in the suburb than the city (maintenance is cheaper than new construction, $m < c_c(0) = c_s$).

In Phase (iii), longer working hours h (or longer commute t_s) make the rich return to the city. If aggregate demand (by the rich) is such that new construction is induced, then rent in the city, $r_c = c_c(s_c^*)$ is greater than rent in the suburb $r_s = m$ (paid by the poor who move there).[16]

To sum up, the model points to the role of work hours in shaping optimal location choice. At short hours, the affordability of housing in the suburbs dominate (once commutable thanks to the automobile), whereas at long hours, the additional space cannot compensate for the (scarce) leisure lost to commuting.

[16] In reality, the displacement of poor households in gentrifying neighborhoods appear to have been modest, suggesting that gentrifiers occupied new construction or rehabilitated unoccupied units [McKinnish et al., 2010, Ellen and O'Regan, 2011], as might be expected from strong protection of renters' rights. Moreove, the lack of displacement, may have contributed to the polarization of incomes in the city. Poor incumbents and newcomers rich enough to afford new construction edging out middle income households.

1.1.1 Model discussion

We have focused on the effect of longer hours rather than that of a higher wage. A higher wage makes the suburb more likely because it lowers the a_c^*/a_s^* while $x_c/x_s = 1$. This is because a constant fraction of income is spent on consumption x and the remainder on housing. A higher wage raise the amount spent on housing. In the suburb, each additional dollar spent on housing raises a_s^* by $1/c_s$. By contrast, in the city, some of the additional demand translates into higher land rent. This result is obviously an artifact of the chosen utility function. (The result regarding longer hours, on the other hand, turns on leisure being increasingly valued when more scarce). In fact, while a constant fraction of income being dedicated to housing makes sense for some ranges of the income distribution, its plausibility starts to fray at very high incomes and especially if housing is in elastic supply. Realistically, at some point, a wage rise likely raises demand for additional leisure more than for additional residential space, a mechanism that would give the city the edge.

Sensitivity to the chosen utility function is one reason we do not focus on comparative statics with respect to the wage. Another reason is that the mechanism we believe have been central to gentrification is not the higher wages facing the rich, but the higher returns to skill, which certainly has impacted wages, but more importantly, it raised the number of hours worked by the skilled. Higher wages in isolation could have a positive, negative, or neutral effect on hours worked, and a strong case could be made for the income effect to dominate the substitution effect at high income levels. Rising returns to skill, by contrast encourages labor supply over leisure, and it is this rise in hours that we believe has been a key driver of gentrification

Evidence of hours as training can be seen in the bundling of hours and wages – the well-paid career track and its long hours may be viewed as a form of training, the successful completion of which results in even higher pay – an arrangement predicated on high returns to skill. High returns to skill, in turn, are commonly linked to the on-going IT revolution and agglomeration economies have favored areas that had a skilled labor force at its beginning in the 1970s. These observations motivate our use of a Bartik-type demand shifter, it being particularly apt at capturing exogenous variation in long hours by the skill.

In our empirical analysis, we will measure the rise in hours by "the rich" as the fraction of the prime age population that is skilled and works full time, FT, and as the above sketched shift illustrates, a rise in FT signals not only more high-income individuals, but also a shift towards favoring central city living (via the effect of longer hours).

Families We have focused on individual labor supply abstracting from the fact that labor supply decisions are made in the context of a family. Thus, we depart from an earlier literature in which married women's labor market participation was subject to the household's location decision [Oi, 1976, White, 1977, Mincer, 1978, Madden, 1980, Madden and White, 1980]. However, we pick up on their recognition of the centralizing potential of more singles or dual-earner households. While it is still true that women's labor supply is more sensitive to commuting cost [Black et al., 2014] and women tend to work more locally, increasingly, the commuting patterns of women are approaching those of men [Edlund et al., 2015, figure 9].

By making everybody, including married women, decide where to live with only their own commute in mind, we build on Costa and Kahn [2000]'s recognition of the co-location problem facing skilled couples (also see Compton and Pollak [2007]). They focused on why large cities may hold particular advantages for this demographic. While recognizing between-city heterogeneity, our focus is on the within-city location choice.

The distinction between the individual and the household becomes moot with positive assortative matching and low degree of intra-household specialization, two trends that arguably have gained currency.[17]

To see how our framework would handle couples and singles, let us assume positive assortative matching and equally many men and women in each skill group. Furthermore, individuals can be married or single. Let us maintain that singles work, but allow for a fraction of married women to not work.

As before, high-wage households are of particular interest and we have three groups to consider: singles, dual-earner couple, and breadwinner-housewife couple. On a per capita basis, the first two household types are similar – they have high earnings and little leisure (compared to the breadwinner-housewife household). In this case, heterogeneity among skilled household could take the following form: singles and dual-earner households locate in the city; the breadwinner-housewife couple locate in the suburb. If breadwinner-housewife couples dominate among the skilled, the singles and dual-earner couples would not fill up the city and rents would remain low allowing the low skilled to reside there as well. As the number of singles or dual-earner couples among the skilled increases, low-skilled households are pushed out.

The addition of children – non-earning members with space requirements – would push households towards the suburb reinforcing the above tendency of the breadwinner-housewife household to locate in the suburb.

[17] For empirical evidence on sorting, see Juhn and Murphy [1997], Heim [2007], DiCecio et al. [2008], McGrattan and Rogerson [2008], Schwartz [2010].

2 Data

Our primary data set is drawn from the decennial censuses of 1980, 1990 and 2000, and the American Community Survey (ACS) pooled 5-year sample for 2010 (years 2008-2012). The chosen level of aggregation is the census tract. The Census wrote: "Census tracts generally have a population size between 1,200 and 8,000 people, with an optimum size of 4,000 people."[18]

Our housing-price measure is based on self-reported values of owner-occupied two-to-three bedroom single family homes.[19] We use households no more than ten years in the current residence on the assumption that owners of more recently transacted units would be more knowledgeable about going market price.[20]

To capture the rise of the high-income-low-leisure demographic, we focus on full-time workers with a college degree, ages 25 to 55. This age group captures prime working ages, the years after college completion but before retirement concerns, and is also a key home buying age group.[21]

Further details on data set and variable construction are in the Data Appendix.

2.1 Sample cities

Geographically, we limit our sample to cities that were in the top-20 (population wise) either in 1970 or 2010. There were 27 such cities which for simplicity we will refer to as "top-20." The list was topped by New York City in both years. Phoenix and Memphis claimed the number 20 spot in 1970 and 2010 respectively.

We used the tract centroid location to calculate the distance to the CBD (Appendix Table A8 lists the cities and the respective CBDs). We include tracts within 35 miles of the CBD regardless of whether they were administratively part of the city. This restriction is arbitrary but arguably delineates a commutable area, the outer reaches of which would be about an hour away from the CBD. For the purposes of this paper, these 35-mile radius circles constitute our cities. We have about 65 thousand tract-year observations, or an average of 600 tracts per city and year.[22]

[18] http://www.census.gov/geo/reference/gtc/gtc_ct.html
[19] Two and three bedroom homes are modal, for new construction see https://www.census.gov/construction/chars/pdf/soldbedrooms.pdf
[20] Including all households yields similar results.
[21] National Association of Realtors [2014].
[22] For disclosure reasons, the sample size is rounded.

2.2 Bartik-type skilled labor demand shifter

We used the public use version of the decennial censuses (IPUMS) to calculate the city-specific demand shifter for skilled employment from the national growth rates of employment of college workers in industry h, excluding the city in question, $-j$, weighted by each industry's 1970 employment share in city j. The base year 1970 was chosen because the rise in returns to skill dates to the IT revolution that started in the ensuing decade [Beaudry et al., 2010].

Specifically, focusing on ages 25-55, we construct our Bartik demand shifter for skilled labor demand for city j and year t as:

$$Z_{jt} = \frac{1}{N_{j,1970}} \sum_{h}^{41} n_{h,j,1970} \times (\ln n_{h,-j,t} - \ln n_{h,-j,1970}), \tag{4}$$

where

$N_{j,t}$ is the number of workers in city j and year $t = 1980, 1990, 2000, 2010$,

$n_{h,j,t}$ is the number of college educated workers in industry h, city j, year t,

$n_{h,-j,t}$ is the number of college workers in industry h and year t, excluding city j. In other words, the first factor is the 1970 city specific industry share in 1970; the second factor is the logged national growth, excluding city j, for that industry in terms of college workers. Thus, Z_{jt} can be interpreted as the share of employment in city j predicted to be held by college educated workers.

Throughout the study period, Z_{jt} is book-ended by San Antonio and Washington DC. In 1980, San Antonio's predicted share of college educated workers was 9 percent; the number for DC was 23 percent. In 2010, those numbers were 18 and 46 percent respectively.

The Bartik measure is city specific (see Table A8).[23] To allow the demand shifter to propagate differentially throughout the city we interact it with a measure of the tract distance from the CBD. We expect the demand shifter to operate more strongly close to the CBD where skilled jobs are concentrated (confirmed by data to be the case).

2.3 Descriptives

We start by presenting descriptive statistics (means) for each year by distance from the CBD. We present these descriptives in tabular form where the data is grouped in four distance bins: 0-3, 3-10, 10-20, and 20-35 miles away (Table 1). For finer parsing by distance, we present smoothed polynomials based on 1-mile distance intervals in a series of graphs.

[23] Except Dallas-Fort Worth, coded as one city in the IPUMS.

House prices Between 1980 and 2010, the median price for a two-or-three bedroom one-family home in the top-20 cities rose by 30 percent from 92.5 to 120.5 thousand 1980 dollars (or from 267 to 348 thousand 2016 dollars). Turning to price changes by distance from the CBD, we see that price increases were higher in more centrally located tracts. In the core (0-3 miles), prices more than doubled. In tracts 3-10 miles out, prices rose by 60 percent, whereas price increases were a mere 10 and 6 percent in tracts 10-20 and 20-35 miles out, respectively. In fact, the price profile flips. In 1980, prices in the periphery were 50 percent higher than in the center. By 2010, it is prices in the center that are higher, by about 40 percent (Table 1 and Figure 1).

Full-time skilled workers We employ the following notation: BA-, less than four-year college; BA, four-year college but no advanced degree; MA+, advanced degree; and BA+ denotes BA and MA+. Let $FT(h, e)$ denote the fraction of adults 25-55 with education $e, e = BA+, MA+$ and work weeks exceeding $h, h = 40, 50$ hours.

The fraction of adults 25-55 who worked full-time and had a college degree increased in the sample cities throughout the study period, a development that was particularly pronounced for women (Table 1 and Figures 5 and 6).[24]

The period also saw a distinctive improvement in the center's ability to attract this better educated and more employed population. In 1980, $FT(40, BA+)$ was higher outside than inside the 10-mile perimeter. By 2010, $FT(40, BA+)$ had risen markedly in the city core (0-3 miles), making up a third of the core's population (compared to a quarter overall). The shift towards the city center was even more pronounced among those working long (50+) hours (Table 1).[25]

Breaking down residence location by gender, we see that full-time skilled women consistently favored the city core, and more so the longer the hours worked and the higher the degree (Figure 6). The main difference over time is the growth in their numbers. Full-time skilled men, on the other hand, show more willingness to live away from the CBD and this is particularly pronounced at the lower skill and hour cutoffs (Figure 5). Over time, however, men, in particular $FT(50, MA+)$ men, approach women in choosing central city location (possibly because many of them are matched to women with not just similar education but also similar hours).

Location of jobs, distance from the CBD Figure 7 shows the distance and skill distribution of jobs across the decades. The figure shows the fraction of jobs held by a given education group (BA-, BA, BA+, MA+) at a given distance from the CBD (among all jobs held by adults 25-55, unconditional on hours, within 35 miles from the CBD, in a given year). We see that

[24] This pattern also held nationally (Figures 3, 4, A3, and A4).

[25] Meanwhile, unskilled full-time workers moved away from the center (Figure A5).

in 1980, skilled and unskilled jobs were concentrated in the city core. By 2010, however, there has been pronounced decline of unskilled jobs inside the 10-mile ring. Skilled jobs, by contrast, maintain their concentration close to the CBD, a concentration that is particularly pronounced for jobs held by workers with a graduate degree.

Age composition We focus on full-time skilled workers, ages 25-55. It is possible that this framing leaves out important demographic developments. Has gentrification not been associated with hipsters and empty nesters?

Table 1 reports the population shares by age group and distance category and we see that the shares of the old and the young (including children) have declined overall, whereas the prime working age group increased by 13 percent (from 40 to 45 percent). Furthermore, the increase was concentrated in the 0-3 mile core, where the share went from 39 to 50 percent over the study period. These patterns are further illustrated in Figure 8. In 1980, the 25-55 age group's presence was j-shaped, bottoming out around 4 miles from the CBD. In 2010, the j had fallen on its back – the prime working ages dominate the city center and decreased monotonically thence.

While young adults, 19 to 24 years old, have long favored the central city, their presence decreased over the study period. Thus, this demographic does not seem to be a prime driver of gentrification, perhaps not surprising considering their limited purchasing power relative to the 25-55 age group.

As for ages 56 and up, this group has grown overall but the growth is concentrated 10 miles out of the CBD. Within 10 miles of the CBD, there is a decrease. This was true of both the 56-65 and the 66+ age groups, although it was more pronounced for the latter (Table 1).

Other demographics Over the period, income (total personal, 1980$) rose by 25 percent, and perhaps unsurprisingly, the gains were concentrated in tracts close to the CBD. In the 0-3 mile core, income rose by almost 80 percent. The percent non-Hispanic white declined by 12 percentage points, whereas the percent blacks increased only slightly (from 19.4 to 19.6 percent). In the central city, however, the pattern was reversed: percent black declined while percent non-Hispanic white held steady. As for marital status, marriage declined overall and in percentage terms the decline was steeper within 10 miles of the city center (25 v. 15 percent), Table 1.

3 Analysis

We start by investigating the reduced form effect of the skilled labor demand shock on housing prices by estimating a regression of the following form:

$$PRICE_{ijdt} = \beta_0 \times Z_{jt} + \boldsymbol{F'_{ijdt}} \boldsymbol{\beta_1} \times Z_{jt} + \alpha_j + \alpha_d + \alpha_t + \epsilon_{ijdt}, \tag{5}$$

where $PRICE_{ijdt}$ is the housing price in tract i at distance d from the CBD of city j in year t, Z_{jt} is the exogenous labor demand shock in city j in year t (see equation (4)) and $\boldsymbol{F_{ijdt}}$ is a $m \times 1$ vector with functions of $dist_{ijdt}$ – tract distance from the CBD – and $\boldsymbol{\beta_1}$ is the conformable vector of parameters. We allow for distance differential impacts of Z_{jt} through $\boldsymbol{F'_{ijdt}} \boldsymbol{\beta_1} \times Z_{jt}$. Our coefficient vector of interest is $\boldsymbol{\beta_1}$, and our hypothesis is that Z_{jt} has a greater impact on prices close to the CBD.

To capture this distance differential effect, we consider three specifications of $\boldsymbol{F_{ijdt}}$:

$$\boldsymbol{F_{ijdt}} = \begin{cases} D3_d = (d1_d, d2_d, d3_d)' & (m=3) \quad \text{or;} \\ d1_d, & (m=1) \quad \text{or;} \\ (dist_{ijdt}, dist^2_{ijdt})' & (m=2), \end{cases}$$

where $dk_d, k = 1, 2, 3$ indicates the 0-3 mile core, the 3-10 mile radius ring, and the 10-20 mile ring respectively (the 20-35 mile ring is the reference category). The third specification allows the distance differential effect to be a quadratic function of distance.

We allow for city, distance and year fixed effects thought α_j, α_d and α_t. Distance fixed effects control for factors such as topography or geology. We discretize the distance fixed effects by using the three distance dummies in $D3_d$. We also consider two-by-two interactions: city-year, city-distance and distance-year fixed effects $(\alpha_{jt}, \alpha_{jd}, \alpha_{dt})$.

City-year fixed effects parcel out time effects that are common to all tracts in a given city, for example, policies implemented at the city level or changes in local legislation.

Tract characteristics can change over time (e.g., endogenous amenities). Distance-year fixed effect account for time evolving characteristics that are related to the location of the tract relative to the CBD. The distance-year fixed effects correspond to year-specific effects in $D3_d$. The choice of $D3_d$ for the distance-year fixed effect is motivated on the grounds of parsimony, the intervals chosen to capture shared price dynamics.[26]

We would like to control for tract characteristics, for instance by including tract fixed effects in equation (5). However, tracts change between the censuses. While possible, the construction of a tract panel data set introduces measurement error and therefore we favor the repeated

[26] Results were similar for finer distance-year fixed effects, therefore the more parsimonious specification was chosen.

cross-sectional data for the main analysis.[27] The city-distance fixed effects consider city-specific effects in $D20_d$, a vector of 20 distance dummies, $rk_d, k = 1, 2, ..., 20$ indicating that the tract is [0,1), [1,2),...,[19-20) mile $r$ing. These city specific 1-mile ring fixed effects may be considered substitutes for tract fixed effects.

The inclusion of the full set of fixed effects means that much of the city-year-distance level variation is absorbed – leaving little, but more exogenous, residual variation for recovering our main parameter vector of interest $\boldsymbol{\beta_1}$.

Throughout, we cluster standard errors at the city level and weigh tracts by their population ages 25-55.[28]

3.1 Bartik-type skilled labor demand shifter on housing prices

Table 2, column 1, shows the results from simply regressing $PRICE_{ijdt}$ on the demand shifter Z_{jt}, city, distance, and year fixed effects. We see that higher Z_{jt} is associated with higher housing prices: 1 unit of Z_{jt} is associated with an additional \$522k. The average change in Z was 0.128 and thus the implied price change is about \$70k (out of an observed difference of \$88k, Table 1, 1980 constant dollars).

The average effect of the demand shifter Z_{jt} masks substantial heterogeneity by distance as can be seen in column 2. The effect in the 0-3 mile core is more than twice as large as the effect in the 3-10 mile ring (588.9/234.5=2.51), and more than six times the effect in the 10-20 mile ring. In this specification, the effect beyond 20 miles is given by the main effect on Z_{jt}. While positive, it is not statistically significant at conventional levels. In sum, we find a positive effect of the demand shock and the effect is concentrated close to the CBD.

Columns 3-5 sequentially introduce city-year, city-distance and distance-year fixed effects. These fixed effects partial out confounders that could be correlated with the demand shock and vary at the corresponding level. Column 3 replaces the city- and year fixed effects with the more flexible city-year fixed effects (the main effect of Z_{jt} can no longer be recovered since it varies at the city-year level) and we see that the results are similar. Column 4 replaces distance fixed effects by city-distance fixed effects and, again, results remain similar.

Column 5 adds distance-year fixed effects, an inclusion that renders the coefficient on the demand shock on the 3-10 mile ring ($d2$) statistically insignificant, but not statistically different from the effect on the 10-20 mile ring ($d3$). The effect on the city core ($d1$), however, is slightly stronger. Therefore, in column 6 we keep the full set of fixed effects but let the demand shock only vary by whether in the 0-3 mile core or not and we find that the city-core effect remains.

[27] We will show that results hold including tract fixed effects using a constructed panel data set in the robustness analysis.

[28] Regression results not using weights were similar.

In Columns 7-9 we let the distance differential effect of Z_{jt} be captured by Z_{jt} interacted with continuous distance squared and introduce city-year, city-distance and distance-year fixed effects sequentially. As expected, the effect of the demand shock decreases with distance but at a decreasing rate. The introduction of more demanding fixed effects reduces the coefficient estimates, but they remain statistically significant throughout.

As a robustness, we also estimate the above series of specifications using logged housing prices (Appendix Table A1).[29] We see similar results, the main exception being that results including distance-year fixed effects only survive in the specification where the distance-differential effect enters squared (column 6).

Overall, results remain qualitatively the same under the alternative fixed effects considered – reassuring evidence that the demand shock is mostly unrelated to other city-year, city-distance and distance-year varying characteristics. Results are also robust to alternative distance-differential effects in $\boldsymbol{F_{ijdt}}$. Henceforth, we focus on the specification using $(d1_d, d2_d, d3_d)$ or $d1_d$ in $\boldsymbol{F_{ijdt}}$ as they capture distance-differential effects using a parsimonious spline.

Since our posited mechanism for rising home prices hinges on high-income households working longer hours, we now turn to investigating the effects of the skilled-labor demand shock on tract demographics.

3.2 Bartik-type skilled labor demand shifter on demographics

We start by investigating how our key demographic – full-time skilled employment – responds to the skilled-labor demand shifter. We let full time be 40 hours or more per week and consider two measures of skill: (1) college or more, $FT(40, BA+)$; and (2) graduate or more, $FT(40, MA+)$. (We also considered a higher cut off for full time, 50 hours or more, but since results are similar they are in the Appendix.)

Table 3, panel A shows the results for $FT(40, BA+)$, full-time workers with a college degree or more, and we follow the same specifications as in Table 2 but skip column 2 for brevity (that is, save for column 1, all specifications include city-year fixed effects).

We see that the demand shock has a positive (but insignificant) effect on our full-time skilled population measure (column 1), but there is important heterogeneity by distance: most of the effect is concentrated in the 0-3 mile core (column 2) and this result is strengthened as fixed effects are added to estimation (column 3 and 4). However, we also see that inclusion of the flexible fixed effects does not leave enough variation to identify effects outside the 0-3 mile core and we therefore drop the ring interaction terms to focus on the city core (column 5). The

[29] Since most homes are purchased as primary residences, the primary driver of willingness to pay is the user value rather than the return on investment. Therefore, we favor prices in levels.

coefficient implies a change in fraction of skilled full-time residents of 16.5 percentage points (129.4×0.128), or 3/4 of the observed change over the period for tracts in the 0-3 mile core.

The results for full-time workers with a graduate degree or more, $FT(40, MA+)$, are in panel B. The implied change in fraction of skilled full-time residents in the 0-3 mile core is 7.4 (57.52×0.128) percentage points, or 80% of the observed change (column 5).

Two components are crucial for the relationship between tract housing prices and the skill and working hours characteristics of tract residents. First, skills are important because skilled workers have high wages and can bid up prices in their preferred locations. Second, skilled workers who face a long work week would want to avoid commuting. These two components, combined with skilled jobs being concentrated in the CBD, leads to our hypothesis that gentrification has resulted from a growing number of high-income households supplying more market hours. In order to investigate the importance of these two pieces, we consider two alternative measures of the local labor force.

First, we look at full-time workers with less than a college degree in column 1 of Table 4. Consistent with our hypothesis that this group would not be able to compete for (and possibly be less interested in) housing in the central city, we see that the estimated effect of the skilled demand shock is negative (and borderline significant) in the city core whereas a positive effect can be found in the third ring ($d3$ or 10-20 miles out).

Second, we look at college men and women, regardless of hours worked. As expected, the demand shock has a weaker effect on their location choice. Working fewer hours, their willingness to live away from the CBD may be higher, column 2, Table 4.

We now turn to other tract characteristics that plausibly change with the Bartik demand shifter: percent black, white (non-Hispanic), married, and average personal income. These variables are correlated with the share of the population that is skilled and works full time, and we expect to find a relationship.

Columns 3-6, Table 4 show the results. As argued, some demographics move in tandem with the work characteristics of the residents. In particular, gentrification is linked to an inflow of high(er) income residents, and income and race are strongly correlated. Interestingly, we also see that gentrification is closely tied to (relatively) more married couples.

As argued before, a relationship is expected since education and employment status are correlated with these other demographics. The reason we favor $FT(\cdot)$ is the direct causal link from growth in a skill-intensive industry to a more skilled and employed population. That is, we view other demographics such as race, income, or marital status, as largely incidental or derived from this primary relationship.

3.3 Housing prices and full-time skilled work

We can now engage our hypothesis that the emergence of centrality as a top amenity is linked to greater labor supply of high-income households. We start by considering a regression of the following form:

$$PRICE_{ijdt} = \alpha_1 FT(h,e)_{ijdt} + \alpha_2 dist_{ijdt} FT(h,e)_{ijdt} + \alpha_3 dist_{ijdt} + \alpha_{jt} + \alpha_{jd} + \epsilon_{ijdt}, \quad (6)$$

where we will consider specifications where FT enters alone and where it is also interacted with distance. The interaction term captures possible differential effects of FT on housing prices by tract distance from the CBD. α_{jt} and α_{jd} are the previously defined city-year and city-distance fixed effects. We also consider adding distance-year fixed effects (α_{dt}) (on top of α_{jt} and α_{jd}).

In column 1, Table 5 we see the results for equation (6) when FT enters alone. Panel A shows the results for $FT(40, BA+)$ and the estimated coefficient implies an average increase in housing prices by \$21k (1.829×12.57). Column 2 adds distance-year fixed effects and the result remains virtually unchanged. Columns 3 and 4 allow for a distance-differential effect of FT by adding an interaction term with distance, and we see that while of the expected sign and statistically significant (column 3), this result wanes once distance-year fixed effects are included (column 4), bringing the estimated effects on full-time skilled workers close to that without the interaction term (column 2). Panel B shows the results for $FT(40, MA+)$ and we see similar results (as were the results for $FT(50, BA+)$ and $FT(50, MA+)$, see Appendix Table A3).

3.3.1 Mechanisms

While the effects of FT on housing prices are surprisingly stable across specifications that control for a flexible set of fixed effects, it is still possible that our findings are driven by omitted variables correlated with both housing prices and tract demographics.

Our strategy for guarding against such confounding is to use a Bartik-type demand shifter for skilled labor. Under the assumptions that the Bartik demand shifter affects housing prices only through the posited channel and is orthogonal to any unobservable tract-by-year characteristics in the housing price equation, we can instrument our full-time skilled measure by the Bartik demand shifter in equation (6).

As the 'Starbucks effect' term suggests, gentrification has been accompanied by a change to local amenities. However, does the appearance of certain retail establishments drive gentrification or is it merely a reflection of changes to the local demographics? If the latter, such tract-by-year changes need not pose a challenge to our identification strategy, they merely mediate effects of a more skilled and employed local population. "Permissible" indirect effects include changes in the retail landscape, law and order, transportation, quality of public schools, etc. that stem from the social, economic or political clout of a skilled, steadily employed population.

More worrying would be if demand growth for skilled labor affected other dimensions that in turn moved housing prices. For instance, a higher Bartik may result in higher tax revenues, which in turn allow for better policing, infrastructure, or civic initiatives that improve quality of life, and possibly more so close to the city center. Alternatively, a higher Bartik could also signal greater demand for office space, where higher prices reflect dwindling supply as residential real estate lose out to commercial such. Demand induced new construction (residential and commercial) would work as a counterweight, and the anecdotal evidence contained in the term "residential conversion" is born out by building permit evidence [Thomas, 2009, 2010, Ramsey, 2012]. Population statistics paint a similar picture, at least of late. Between 2000 and 2010, the central city population grew, reversing decades of population loss [Baum-Snow and Hartley, 2016].

Before moving to the IV results where we instrument FT using the Bartik demand shifter, we now turn to discussing alternative mechanisms.

Time-invariant tract characteristics While many amenities change over time, some are largely fixed. Examples include amenities related to topography or location (including centrality). To account for time-invariant tract effects, we construct a panel of tracts using cross walk files from US2010[30] in order to add tract fixed effects to equation 5. The cross-walk procedure is however such that there is a loss of fidelity to the underlying demographics. With this caveat in mind, Table 6, column 1, shows the results from adding tract fixed effects to the column 4 and 5 specifications of Table 2 in Panel A and B respectively.[31] Results are quite similar to those found in the cross sectional version of the data set, suggesting that the set of fixed effects, notably city-distance fixed effects, were passable substitutes for tract fixed effects.

Lower crime? Violent crime rose through the 1970s and 1980s, but started to decline in the early 1990s. Since the decline in crime has been argued as a possible cause for gentrification, we separate the years 1980 and 1990 from the years 2000 and 2010. This allows us to look at a period in which crime rose and one in which it declined.

Despite rising crime, the effects for the early years are similar to that of the whole period,

[30] `http://www.s4.brown.edu/us2010/Researcher/Bridging.htm`
[31] City-distance fixed effects are absorbed by the tract fixed effects.

Table 6, column 2. Results remain statistically significant through the inclusion of city-year and city-distance fixed effects (Panel A), but lose significance once distance-year fixed effects are added (Panel B).[32] Results for 2000 and 2010 in column 3 are stronger.

An alternative tack is to split the sample by the decline in crime. The city grouping was done with a view to split the sample in terms of number tracts. We group cities that saw large declines in crime and those that saw modest declines or even increases over the 1985-2012 period.[33] Qualitatively, results hold in both groups (Table 6, columns 4 and 5), but we also see that cities with large declines in crime saw a stronger response to the Bartik shifter.

Some of the cities with the steepest housing price increases have also seen the largest declines in crime, New York City being a case in point. New York City is also the largest US city and its prominence in finance, business, and culture means that its property market may also be singular. For instance, foreign buyers constitute a significant share of demand at the high end of the real estate market. For these reasons, we exclude New York City and find similar effects among the remaining cities, Table 6, column 6.

Taken together, our interpretation of these findings is that while the fall in crime is not behind the trend towards gentrification, crime nonetheless plays a role in location choice, high crime in particular working as a damper on gentrification.

Better public schools? Good suburban- and faltering urban public schools were often mentioned reason as for suburbanization. During the study period, several reforms aimed at improving urban schools, such as charter schools and vouchers, were introduced. If urban public schools improved as a result, this could be a reason for the city to regain attractiveness. While school quality is undoubtedly an important local amenity, two reasons make us question its role in driving gentrification.

First, school quality is highly endogenous to the local demographics, through peer effects, parent involvement, and local school financing, thus leaving school quality to a large extent outside of the control of "remedial" school policies [Rothstein, 2006]. This does not mean that city public schools have not improved, simply that to the extent they have, changing demographics may be the prime driver.

Second, as mentioned, children are a dwindling demographic in the central city. In 1980, the 6-18 age group made up about 9 percent of the population in the city core, by 2010 that number was close to 6 (Table 1). In other words, the childlessness that characterized early

[32] Since the analysis breaks the sample by only two consecutive years (which are likely similar) adding the very demanding specification with both metro-year and distance-year fixed effects absorbs most of the variation of the instrument.

[33] The years for which crime statistics are readily available. `http://www.ucrdatatool.gov/Search/Crime/Local/TrendsInOneVarLarge.cfm`

gentrifiers (e.g. yuppies or gays [Black et al., 2002]) remains, perhaps unsurprising considering children's effect on the space-to-earnings ratio.

Population growth While the US and the cities in our sample grew substantially over the study period, not all of our cities grew. In fact, 10 of the 27 cities shrank, losing on average 29% of their population since 1970. Detroit and Saint Louis led the pack, losing almost half its population (Appendix Table A7).[34]

Cities whose population decreased are interesting for a number of reasons. As mentioned, growth in the number of rich households may be one reason prices have risen in the central city. For cities that lost half of their populations, this factor is likely to be absent.

Another reason to look at cities by population growth is that real estate is durable and we want to make sure that our results are not driven by price declines as demand rescinds.

Congestion is another reason to be interested in cities that shrank. Overall, the cities in our sample gained population and congestion may have increased as a result. Since congestion makes commuting longer and less predictable, growing congestion rather than longer work hours may be the reason suburbs have fallen out of fashion. The cities that shrank are instructive in this regard since it is reasonable to believe congestion to have eased or at least not increased in these cities.

Lastly, the presence of foreign buyers on the US real estate scene is a reason to look at cities that shrank. In our sample, cities that shrank were concentrated in the rust belt, a region of limited appeal to foreign buyers.

Table 6 columns 7 and 8 show the results from splitting the sample by population growth (negative or positive). We see that the results are quite similar in the two subsamples, corroborating the price picture seen in Appendix Figures A1 and A2. The inclusion of distance-year fixed effects (Panel B) moves the magnitude of the coefficient estimates but does not change the qualitative flavor of the results.

That is, even for cities that shrank, we find that prices near the CBD have done relatively well. The difference seems to be a matter of levels, population loss resulting in lower overall price pressure. For cities that grew, the demand shock propagated *throughout* the city, but was substantially stronger in the 0-3 mile core.

[34] The reason for using 1970 as the start year rather than 1980 is that we view 1970 as the start year of the processes driving gentrification. Since we obtain similar results in the two groups, we surmise that the exact grouping is not important. Further, tracking population growth by year, changes were largely monotonic.

3.3.2 IV

In the previous set of regressions, we have seen that the inclusion of city-year, city-distance and distance-year fixed effects, while important, leaves little residual variation in the demand shock for our IV strategy. In the presence of weak instruments, IV results could be as severely biased as OLS results. Therefore, we will consider results with city-year and city distance fixed, along with the full set of fixed effects, keeping in mind that the latter is quite demanding.

Table 7 presents the results. In column 1, FT is instrumented by $(d1_d, d2_d, d3_d) \times Z_{jt}$. We see a statistically significant positive effect, similar in magnitude to the OLS results. However, the positive effect becomes statistically insignificant once distance-year fixed effects are included (column 2). In this specification, the effects of the demand shock on FT mainly holds in the first distance ring (see Table 3, column 4), and the test for weak instruments also points in this direction (the test statistics indicates that the 2SLS bias could be as large as 30%). This is perhaps not surprising given that the fixed effects absorb much of the variation in our instruments.

Therefore, in column 3 we consider as instrument only $d1_d \times Z_{jt}$, which we know has a strong first stage (Table 3, column 5). The IV estimate is now twice as large as the OLS estimates.

In columns 4 and 5 the effect of FT is allowed to vary with distance, as it is reasonable to believe that a given change in housing demand affects prices more when closer to the CBD (from housing supply being less elastic). We again see a positive and fading effect. Once the full set of fixed effects are included, the main effect on FT is slightly reduced, but the linear interacting remains negative and statistically significant, in contrast to the OLS results.

We note that whenever the full set of fixed effects are included and weak instruments are of concern (columns 2 and 5), the IV results line up in magnitude with the OLS results. However, when instruments are strong (columns 3 and 4) the IV results are larger in magnitude.

Under the necessary IV assumptions, we find that the causal effect of FT on housing prices is larger than the effect estimated by OLS. New construction is a candidate reason for why OLS would underestimate the causal effect of FT. While the bulk of residential construction is still greenfield development, since the early 1990s there has been a marked shift towards the city core [Thomas, 2009, 2010, Ramsey, 2012].[35]

The specification in column 3 includes the full set of fixed effects and has a strong first stage. However, it suffers from not allowing the effect of FT on prices to vary with distance from the CBD, of concern since housing supply elasticity varies systematically with distance from the CBD. This limitation is illustrated in Figure 9 which shows the predicted price changes. We see that the model does well close to the CBD but over-predicts price changes away from the

[35] We present the IV results for the alternative specifications and samples of Table 6 in the Appendix.

CBD.

To allow FT to have a distance differential effect on prices, we revert to using three instruments, $(d1_d, d2_d, d3_d) \times Z_{jt}$. We favor the specification with only metro-year and metro-distance fixed effects (column 4, Table 7), because inclusion of distance-year fixed effects renders the first stage weak (columns 5, Table 7); Figure 10 shows the implied price changes and we see that they track the observed changes closely.

4 Discussion

Suburbanization dominated the US urban landscape for most of the 20th Century. As the century drew to a close, however, it was clear that a counter movement was afoot. Today, gentrification has grown out of its erstwhile niche status to headline a broad based comeback of the central city.

The driving factor, we have proposed, can be found in a greater labor supply of high-income households. Suburban living offers spacious living against a commute and with little non-market time, the enjoyment of the former may be reduced, while the latter becomes more onerous.

The ideas collated in this paper are by no means new. They hew closely to the canonical models of land and time use. The employment of a Bartik demand shifter also follows a well-beaten path. To the best of our knowledge, however, ours is the first paper to emphasize the dwindling non-market time of high-income households as *the* explanation for gentrification.

We have focused on individual labor supply and lumped men and women together. In the preliminary analysis we looked at men and women separately but did not find gender differential results, possibly because the expansion of hours have been qualitatively similar for skilled men and women. We believe it quite possible, however, that had the ever harder working skilled men been paired with full-time housewives, urban revival may not have happened.

The labor and housing market trends studied in this paper are not unique to the US, but their manifestations may be context specific. For instance, while a number of European cities have seen similar price pressure in the central city, the starting points have been different since Europe never had US-style suburbanization. Europe's better urban infrastructure at the time of suburbanization certainly played a role [Hohenberg and Lees, 1995, Brueckner et al., 1999]. Less discussed, however, is the greater purchasing power of the US middle class. Circa 1850, US overtook Western Europe in terms of GDP per capita, and by 1950 the latter was a mere half of the former.[36] In other words, the limited purchasing power of the European middle class post WWII may have contributed to their choosing existing city-core real estate rather than

[36] The Maddison-Project `http://www.ggdc.net/maddison/maddison-project/home.htm`

seeking out new greenfield construction, leaving the latter for low cost or public housing.

Gentrification is about price growth and changes to the housing stock, not population growth. The suburbs will likely continue to be the destination of choice, if not aspiration, for the vast majority. If the forces pointed to in this paper persist, however, the demographic make up of suburbs will change, and with it, some of suburbia's hitherto most bankable characteristics.

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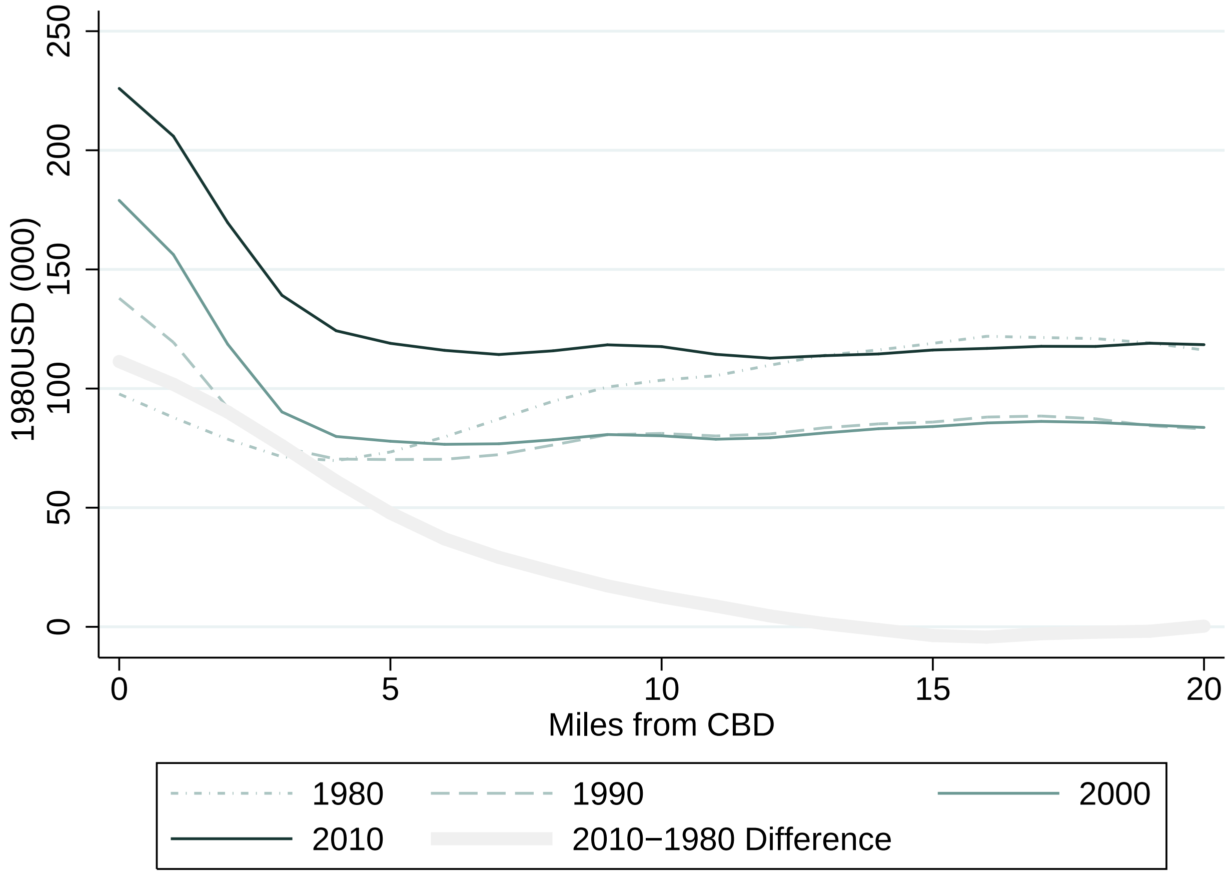
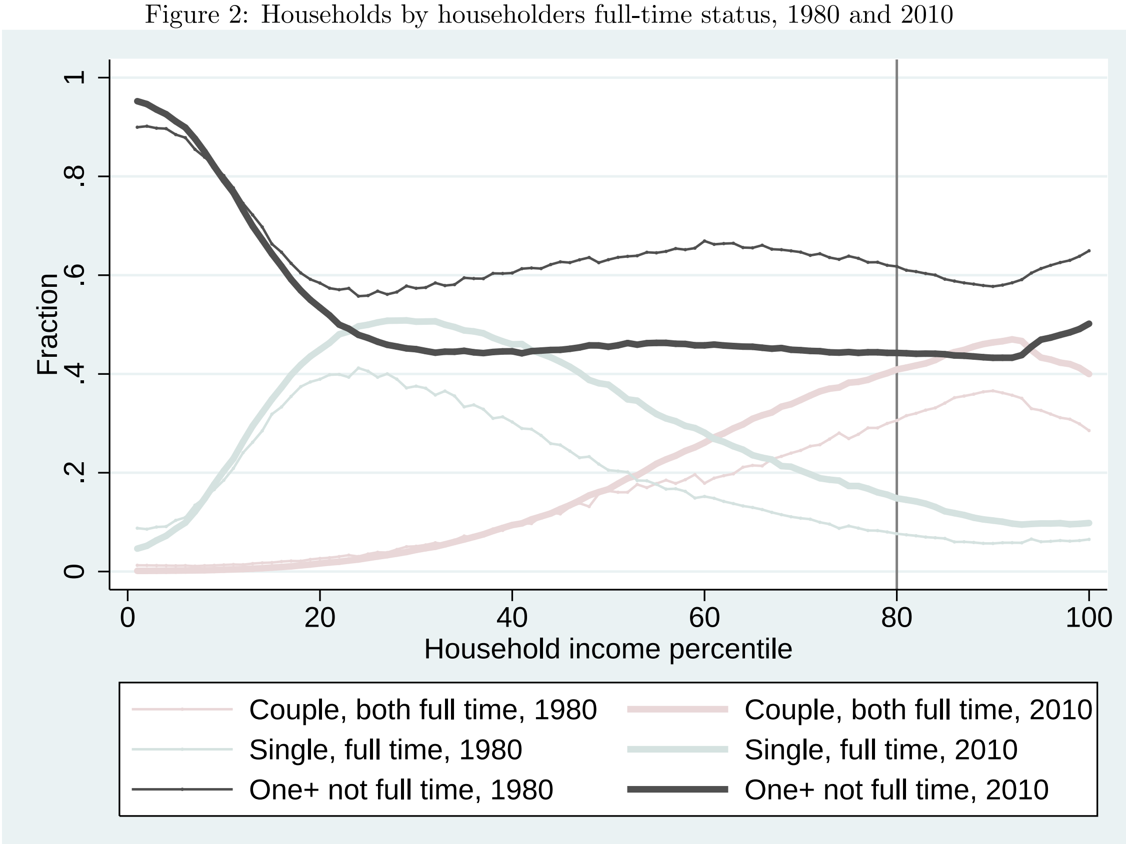
Graphs

Figure 1: Home prices by distance from the CBD



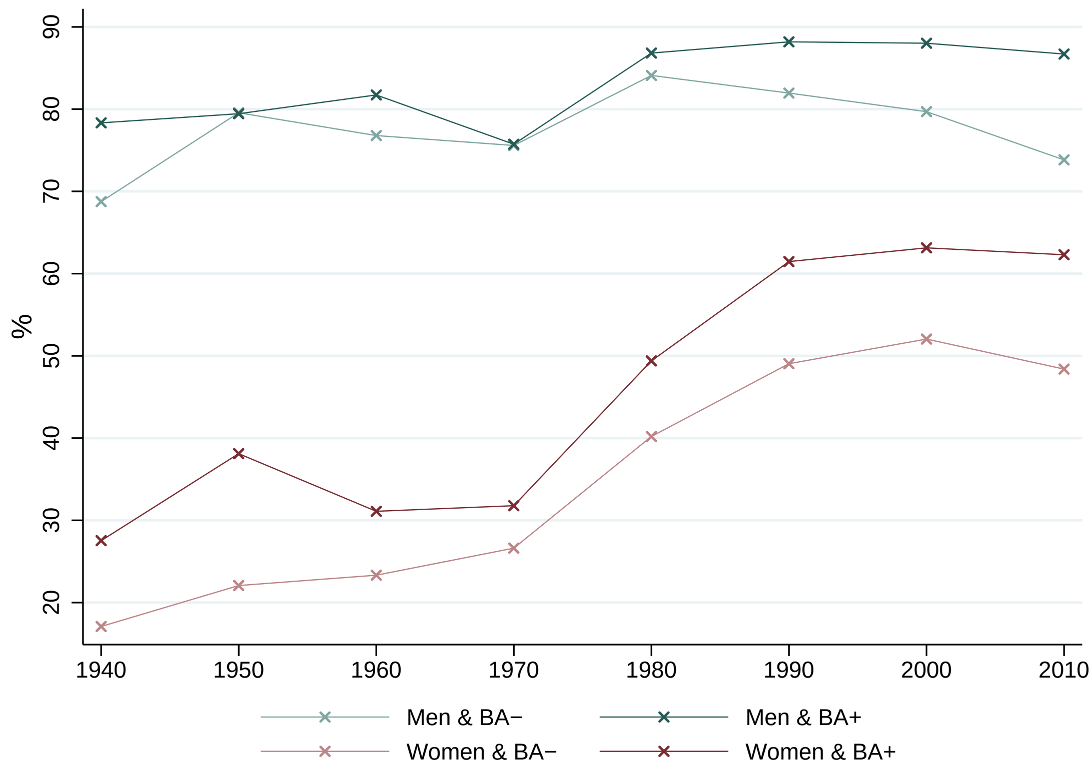
Notes: The figure shows the median price (1980$) for owner-occupied, 2-3 bedroom, one-family homes in our top-20 US cities, by distance from the CBD. See the Appendix for further details on variable and sample construction, notably Table A8. 20 miles includes 20-35 miles.
Source: Decennial censuses and the American Community Survey, restricted use data.

Figure 2: Households by householders full-time status, 1980 and 2010



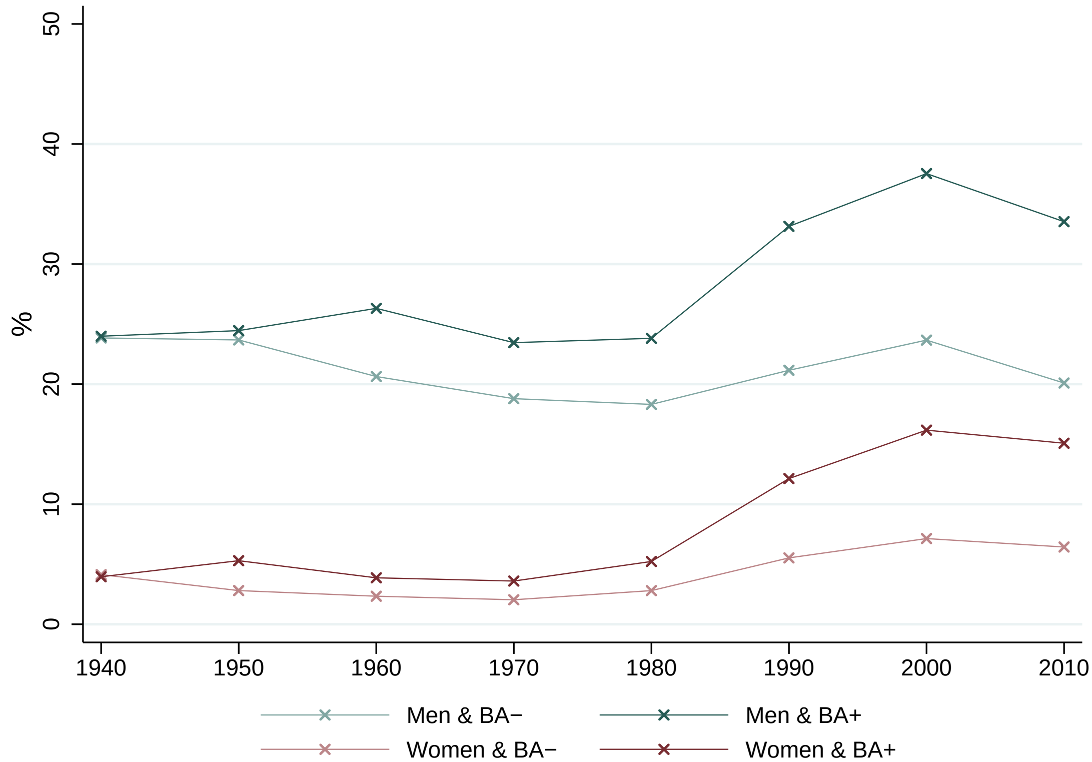
The black lines show the fraction of households at each percentile in the household income distribution that has at least one of its householders (head or spouse) who does not work full time (40 hours or more per week, 40 or more hours per year); it is 1 minus the fraction single (blue line) and couple (red line) households where head and spouse (if applicable) work full time. Household income is computed as the sum of total personal income for head and spouse. The universe is all households in which either head or spouse is between ages 25 and 55 and not in group quarters.
Source: IPUMS.

Figure 3: % Full time, 40+h/week, by sex and education



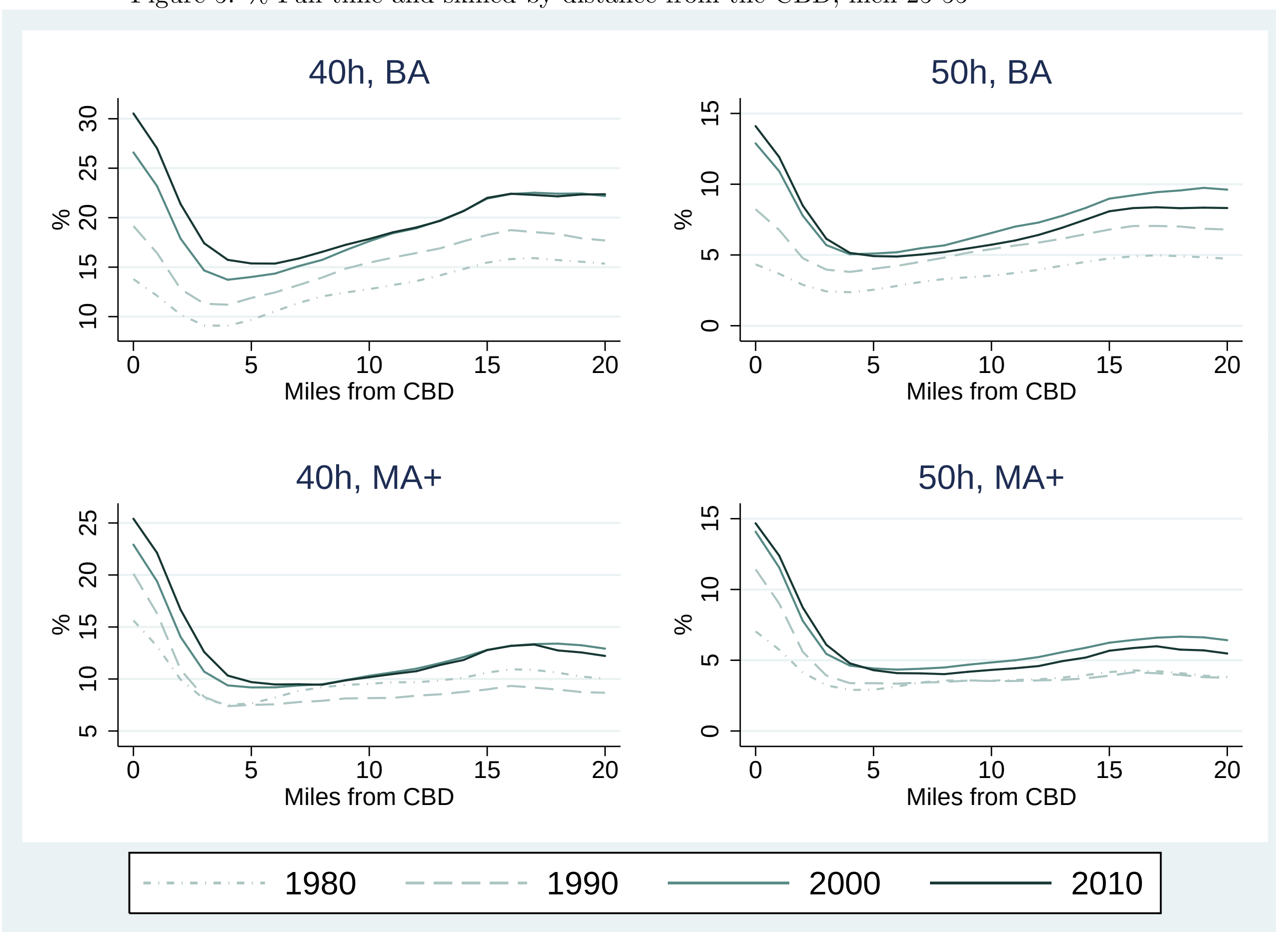
Note: Ages 25-55.
Source: Decennial censuses, integrated public use micro data series (IPUMS).

Figure 4: % Full time, 50+h/week, by sex and education



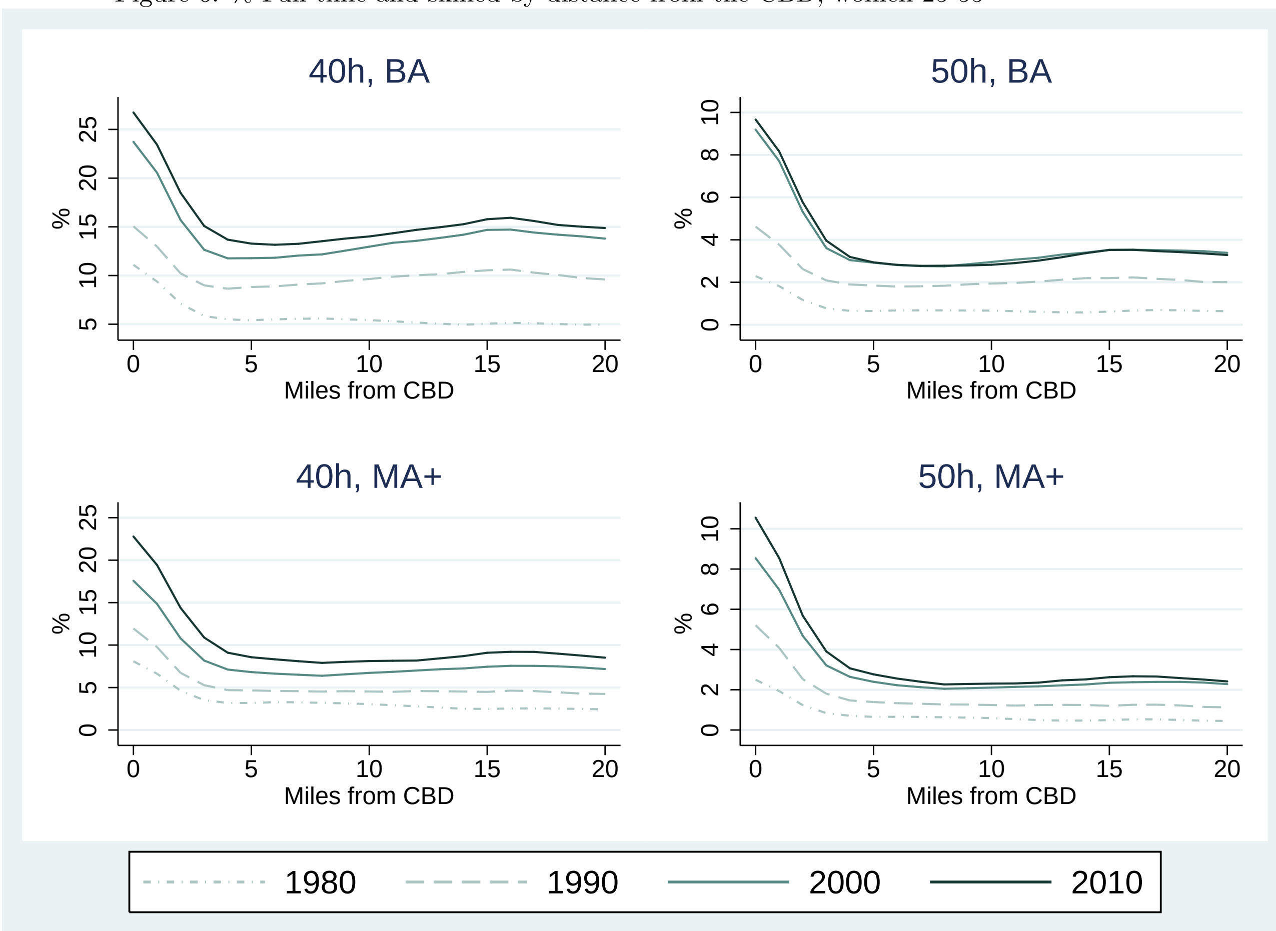
Note: Ages 25-55.
Source: Decennial censuses, integrated public use micro data series (IPUMS).

Figure 5: % Full time and skilled by distance from the CBD, men 25-55



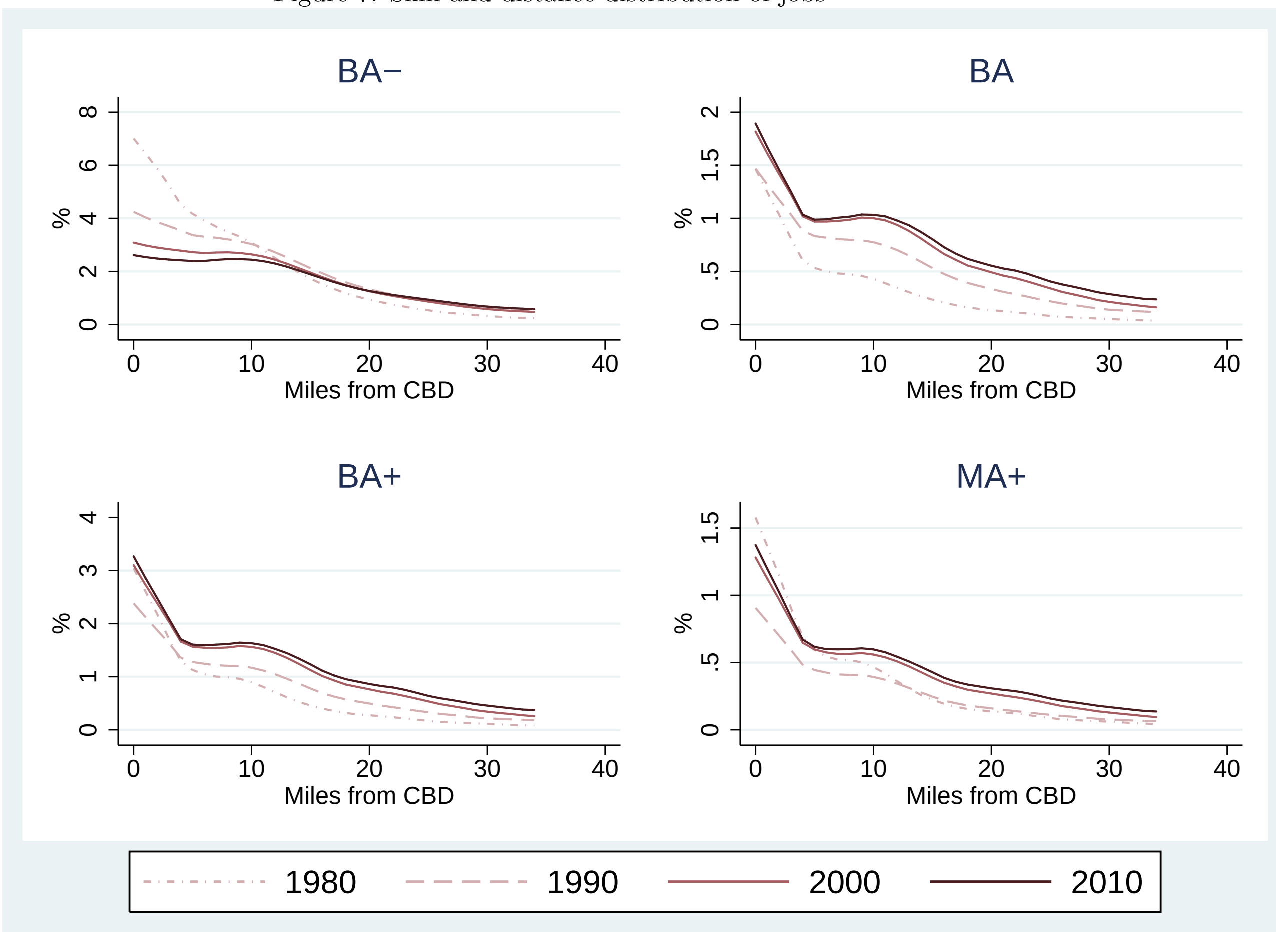
Universe: Men 25-55 residing $x = 0, 1, ...18, 19, 20 - 35$ miles from the CBD. Source: Decennial censuses and the American Community Survey, restricted use data.

Figure 6: % Full time and skilled by distance from the CBD, women 25-55



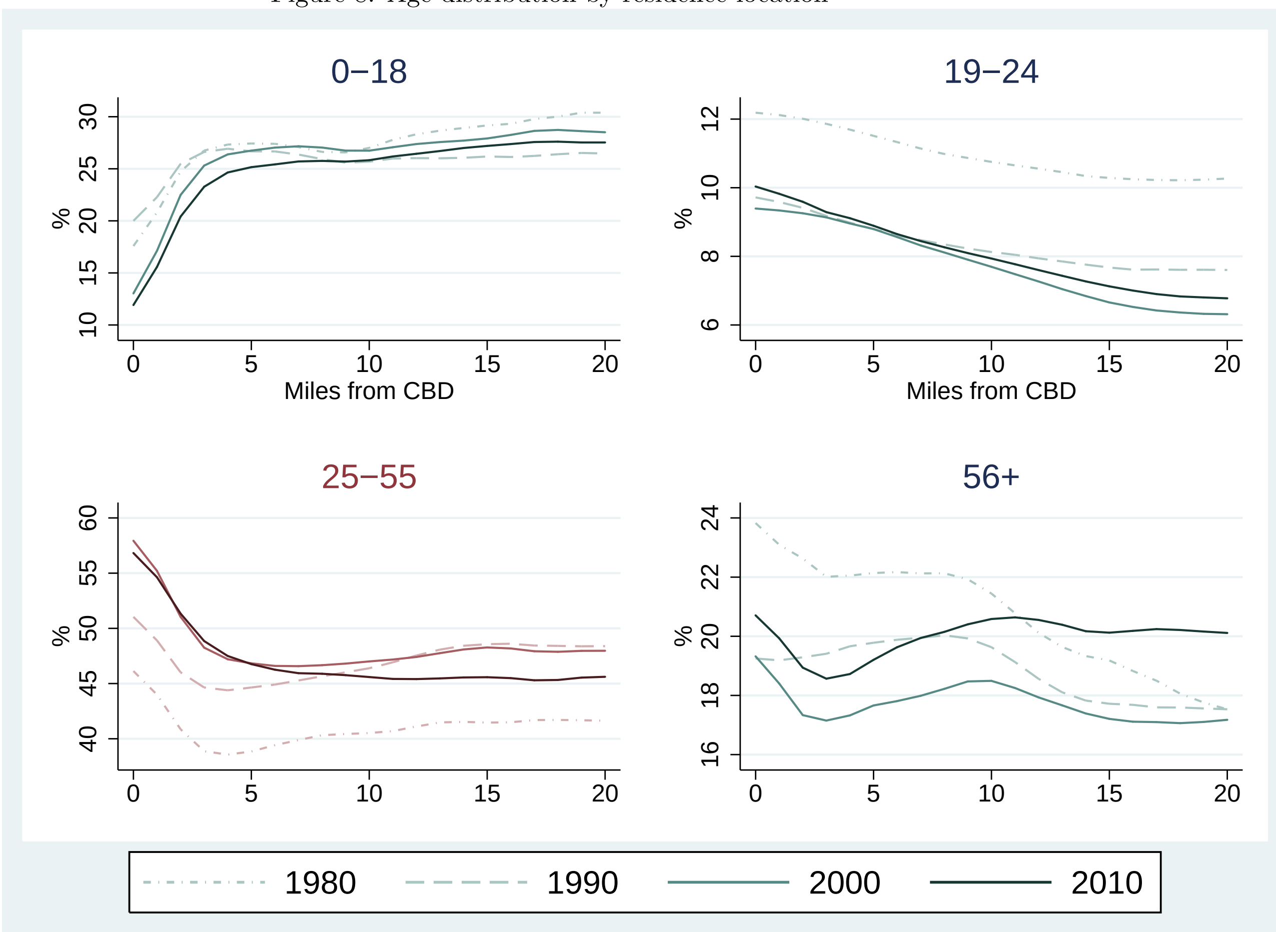
Universe: Women 25-55 residing $x = 0, 1, ...18, 19, 20 - 35$ miles from the CBD. Source: Decennial censuses and the American Community Survey, restricted use data.

Figure 7: Skill and distance distribution of jobs



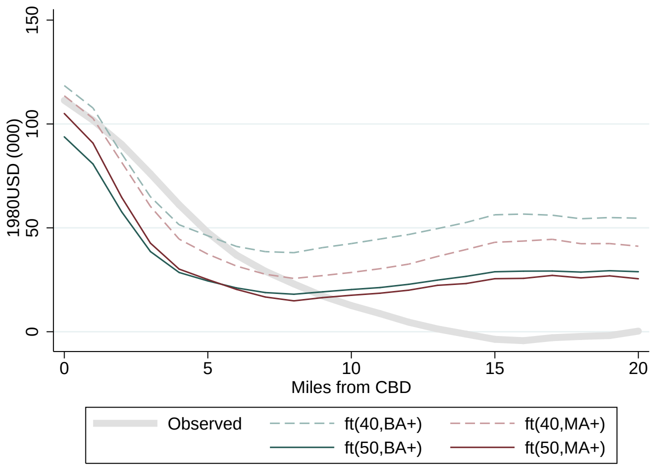
Notes: The universe is the jobs within 35 miles of the CBD in a given year, held by workers 25-55 who work away from home. For instance, the bottom left panel says that in 2000, 3 percent of jobs were located in the center (0-1 mile radius) and were held by a worker with four year college or more.
The skill level of the job is given by the education level of the person who held the job.
Source: Decennial censuses and the American Community Survey, restricted use data.

Figure 8: Age distribution by residence location



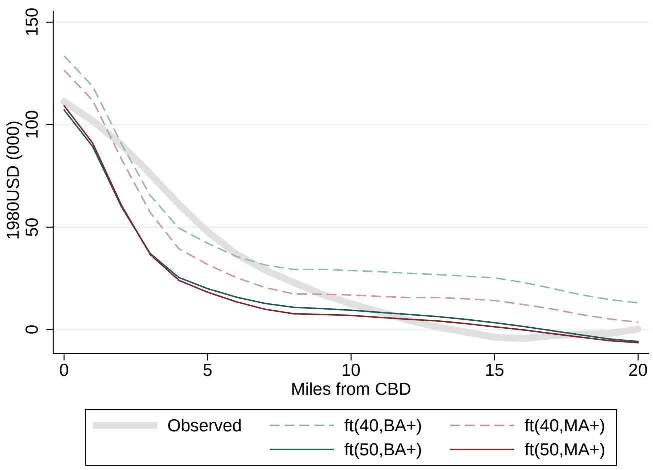
Universe: Residents residing $x = 0, 1, ...18, 19, 20 - 35$ miles from the CBD.
Source: Decennial censuses and the American Community Survey, restricted use data.

Figure 9: Predicted v. Actual Price increase, ‘000 1980$



This figure graphs the predicted price change from Table 7, column 3.

Figure 10: Predicted v. Actual Price increase, ‘000 1980$



This figure graphs the predicted price change from Table 7, column 4.

Tables

Unless otherwise specified, the analysis is based on the decennial censuses and the American Community Survey, restricted use data. Throughout, sample sizes have been rounded to nearest 1000 for disclosure reasons. The repeated cross section has 65 thousand tract-years (53 thousand excluding New York); and the panel data set has 48 thousand tract-years.

Table 1: Summary Statistics

		(1)	(2)	(3)	(4)	(5)
		Distance to the CBD (miles)				
Variable	Year	*d*1=[0,3]	*d*2=(3,10]	*d*3=(10,20]	*d*4=(20,35)	[0,35)
House price	1980	66.64	79.16	108.23	114.06	92.5
('000 1980$)	2010	154.77	115.07	119.22	120.5	120.54
	Δ	88.13	35.91	10.99	6.44	28.04
FT(40,BA+)	1980	13.78	12.92	15.19	15.05	14.05
	2010	35.13	23.15	27.22	28.29	26.62
	Δ	21.35	10.23	12.03	13.24	12.57
FT(40,MA+)	1980	6.37	5.42	6.12	5.64	5.77
	2010	15.5	8.92	10.1	10.35	10.13
	Δ	9.13	3.5	3.98	4.71	4.36
FT(50,BA+)	1980	4.03	3.43	4.3	4.44	3.92
	2010	14.32	7.25	8.81	9.69	8.86
	Δ	10.29	3.82	4.51	5.25	4.94
FT(50,MA+)	1980	2.29	1.82	2.06	1.93	1.96
	2010	7.28	3.4	3.8	4.02	3.95
	Δ	4.99	1.58	1.74	2.09	1.99
Income	1980	10.53	12.06	14.25	14.3	12.94
('000 1980$)	2010	17.98	13.99	17.22	18.77	16.53
	Δ	7.45	1.93	2.97	4.47	3.59
White	1980	48.99	62.43	75.61	85.73	68.87
	2010	44.97	38.81	53.91	66.37	51.06
	Δ	-4.02	-23.62	-21.7	-19.36	-17.81
Black	1980	32.89	23.61	13.41	6.78	18.7
	2010	25	27.22	15.43	7.49	18.25
	Δ	-7.89	3.61	2.02	0.71	-0.45

Table 1: Summary Statistics, continued

		(1)	(2)	(3)	(4)	(5)
		Distance to the CBD (miles)				
Variable	Year	$d1$=[0,3]	$d2$=(3,10]	$d3$=(10,20]	$d4$=(20,35)	[0,35)
Married	1980	46.29	62.67	72.22	77.35	66.32
	2010	36.13	48.25	60.72	66.59	56.14
	Δ	-10.16	-14.42	-11.5	-10.76	-10.18
Ages:						
0-5	1980	8.03	7.85	7.51	8.23	7.82
	2010	6.99	8.32	8.04	8.12	8.08
	Δ	-1.04	0.47	0.53	-0.11	0.26
6-12	1980	9.04	9.56	10.09	11.02	9.9
	2010	6.58	9.02	9.63	10.12	9.33
	Δ	-2.46	-0.54	-0.46	-0.9	-0.57
13-18	1980	8.97	9.66	10.62	11.35	10.16
	2010	6.05	8.12	8.64	8.83	8.33
	Δ	-2.92	-1.54	-1.98	-2.52	-1.83
19-24	1980	12.45	11.21	10.41	10.46	10.97
	2010	10.31	8.58	7.36	6.77	7.84
	Δ	-2.14	-2.63	-3.05	-3.69	-3.13
25-55	1980	39	38.7	40.52	40.81	39.63
	2010	50.45	45.53	44.64	44.63	45.34
	Δ	11.45	6.83	4.12	3.82	5.71
56-65	1980	9.74	10.86	10.67	9.21	10.42
	2010	9.67	9.88	10.7	10.88	10.39
	Δ	-0.07	-0.98	0.03	1.67	-0.03
66-	1980	12.76	12.16	10.18	8.93	11.09
	2010	9.95	10.55	10.99	10.64	10.68
	Δ	-2.81	-1.61	0.81	1.71	-0.41

Note: percent unless otherwise indicated. Income is total personal income. Source: Decennial censuses and the American Community Survey, restricted use data.

Table 2: Effects of Bartik-type demand shock on housing values

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Dependent Variable: House price ('000) 1980$								
Z	522.0*	425.7							
	[278.0]	[264.1]							
$Z\times$									
$d1$		588.9***	580.7***	633.1***	777.4***	561.7**			
		[168.6]	[169.1]	[123.1]	[264.1]	[259.7]			
$d2$		234.5***	249.7***	285.2***	235.6				
		[52.21]	[49.95]	[54.47]	[144.8]				
$d3$		88.25***	98.22***	153.8***	319.5*				
		[18.25]	[18.49]	[41.01]	[173.0]				
$Z\times$									
$dist$							-50.30***	-47.79***	-42.65***
							[13.92]	[7.843]	[9.668]
$dist^2$							1.053***	0.928***	0.819***
							[0.307]	[0.156]	[0.150]
R^2	0.317	0.333	0.362	0.400	0.401	0.401	0.353	0.401	0.402
Fixed effects:									
City	✓	✓							
Year	✓	✓							
City-Year			✓	✓	✓	✓	✓	✓	✓
City-Distance				✓	✓	✓		✓	✓
Distance-Year					✓	✓			✓

Regressions 1-3 include distance controls $d1, d2, d3$; regressions 7-9 include linear and square continuous distance controls $(dist, dist^2)$.
Z is the Bartik demand shifter, see Equation 4, also Table A8. $d1, d2$, and $d3$ indicate distance intervals 0-3, 3-10, 10-20 miles from the CBD, respectively.
The unit of observation is a tract and each regression has 65-thousand tract-years.
Significance levels: *** $-$ 0.01; ** $-$ 0.05; * $-$ 0.1. Standard errors are clustered at the city level; tracts are weighted by population size (25-55).
Source: Decennial censuses and the American Community Survey, restricted use data.

Table 3: Effects of Bartik-type demand shock on full-time skilled workers

	(1)	(2)	(3)	(4)	(5)
	Dependent Variable:				
	A. $FT(40, BA+)$				
Z	11.56				
	[13.91]				
$Z\times$					
$d1$		97.27***	33.10**	120.6*	129.4***
		[12.58]	[13.43]	[59.46]	[39.51]
$d2$		16.94	-31.30***	24.02	
		[14.58]	[8.369]	[44.49]	
$d3$		6.977	-16.11*	-54.85*	
		[16.93]	[8.549]	[29.14]	
R^2	0.185	0.203	0.318	0.320	0.320
	B. $FT(40, MA+)$				
Z	11.73**				
	[4.520]				
$Z\times$					
$d1$		52.17***	14.22***	52.46**	57.52***
		[6.621]	[4.024]	[21.24]	[16.07]
$d2$		12.34	-15.66***	6.307	
		[10.97]	[3.892]	[17.57]	
$d3$		8.080	-7.354	-22.21	
		[10.78]	[4.823]	[15.33]	
R^2	0.167	0.185	0.283	0.285	0.284
Fixed effects:					
city	✓				
year	✓				
city-year		✓	✓	✓	✓
city-distance			✓	✓	✓
distance-year				✓	✓

Regressions 1-2 include distance controls $d1, d2, d3$.
Z is the Bartik demand shifter, see Equation 4, also Table A8. $d1, d2$, and $d3$ indicate distance 0-3, 3-10, 10-20 miles from the CBD, respectively.
The unit of observation is a tract and each regression has 65-thousand tract-years.
Significance levels: *** – 0.01; ** – 0.05; * – 0.1. Standard errors are clustered at the city level; tracts are weighted by population size (25-55).
Source: Decennial censuses and the American Community Survey, restricted use data.

Table 4: Effects of Bartik-type demand shock on other demographics

	(1)	(2)	(3)	(4)	(5)	(6)
	Dependent Variable:					
	%					('000) 1980$
	$FT(40, BA-)$	$BA+$	Black	White	Married	Income
$Z\times$						
$d1$	-0.62	85.72	-92.67	268.2***	103.9***	63.70*
	[0.376]	[55.53]	[67.05]	[49.59]	[24.01]	[34.16]
$d2$	0.029	14.69	-52.56	141.7**	70.97**	9.523
	[0.314]	[59.31]	[52.06]	[58.50]	[27.07]	[14.24]
$d3$	0.516*	-76.31*	-17.5	63.12	51.39**	-5.304
	[0.284]	[39.51]	[51.28]	[58.72]	[18.62]	[13.84]
R^2	0.261	0.291	0.279	0.444	0.477	0.295

All regressions include city-year, city-distance and distance-year fixed effects.
Z is the Bartik demand shifter, see Equation 4, also Table A8. $d1, d2$, and $d3$ indicate distance intervals 0-3, 3-10, 10-20 miles from the CBD, respectively.
The unit of observation is a tract and each regression has 65-thousand tract-years.
Significance levels: *** – 0.01; ** – 0.05; * – 0.1. Standard errors are clustered at the city level; tracts are weighted by population size (25-55). Source: Decennial censuses and the American Community Survey, restricted use data.

Table 5: The relationship between full-time skilled workers and housing prices

	(1)	(2)	(3)	(4)
	Dependent Variable: House price ('000) 1980$			
	A. $FT(40, BA+)$			
FT	1.829***	1.831***	2.037***	1.838***
	[0.167]	[0.167]	[0.164]	[0.147]
$FT \times dist$			-0.0170**	-0.000484
			[0.00686]	[0.00501]
R^2	0.475	0.482	0.475	0.482
	B. $FT(40, MA+)$			
FT	3.502***	3.507***	3.635***	3.334***
	[0.340]	[0.342]	[0.335]	[0.309]
$FT \times dist$			-0.0115	0.0144
			[0.0163]	[0.0130]
R^2	0.475	0.482	0.475	0.482
Fixed effects:				
City-Year	✓	✓	✓	✓
City-Distance	✓	✓	✓	✓
Distance-Year		✓		✓

Regressions 3-4 include continuous distance control, *dist*.
The unit of observation is a tract and each regression has 65-thousand tract-years.
Significance levels: *** – 0.01; ** – 0.05; * – 0.1. Standard errors are clustered at the city level; tracts are weighted by population size (25-55). Source: Decennial censuses and the American Community Survey, restricted use data.

Table 6: Effects of Bartik-type demand shock on housing values – robustness

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Dependent Variable: House price ('000) 1980$							
	Sample:							
		Cross Section:						
		Years:		Crime decline:			Population:	
	Panel	1980/1990	2000/2010	High	Low	not NYC	Shrunk	Grew
	Panel A. City-year and City-distance FE							
$Z\times$								
$d1$	655.5***	752.3***	1164.2***	728.6***	511.2***	493.3***	596.9***	661.3***
	[169.4]	[143.5]	[179.5]	[187.8]	[92.62]	[62.16]	[88.75]	[190.4]
$d2$	299.7***	449.8***	531.4**	285.2***	290.3**	266.7***	352.6***	241.0***
	[60.29]	[112.4]	[228.5]	[43.39]	[114.6]	[71.79]	[100.7]	[66.12]
$d3$	125.2*	298.7***	175.8**	99.77**	241.4***	150.1**	239.9**	102.8**
	[61.03]	[107.0]	[79.86]	[37.41]	[70.42]	[57.38]	[77.41]	[41.01]
R^2	0.591	0.188	0.613	0.356	0.346	0.408	0.241	0.436
	Panel B. City-year, City-distance, and Distance-year FE							
$Z\times$								
$d1$	856.2**	533.2	2464.4***	998.3	565.7***	591.8***	622.2***	1190.0**
	[375.1]	[454.2]	[635.1]	[618.4]	[108.0]	[111.3]	[148.9]	[514.0]
$d2$	271	-146.3	1489.6	359.5	244.8**	225.1*	264.2	552.3**
	[194.1]	[444.8]	[1000.5]	[231.5]	[112.0]	[125.3]	[149.0]	[223.9]
$d3$	431.6*	456.6	280.2	473.6***	398.3***	325.8*	474.6***	354.8**
	[251]	[552.0]	[180.3]	[120.5]	[117.2]	[170.1]	[146.7]	[151.3]
R^2	0.562	0.188	0.613	0.356	0.348	0.409	0.244	0.436

Column 1 includes tract fixed effects.
Z is the Bartik demand shifter, see Equation 4, also Table A8. $d1, d2$, and $d3$ indicate distance 0-3, 3-10, 10-20 miles from the CBD, respectively.
The unit of observation is a tract and sample sizes are as follows: column 1: 48 thousand; columns 2-5, 7-8: about 65/2 thousand; column 6: 53 thousand tract-years.
Significance levels: *** – 0.01; ** – 0.05; * – 0.1. Standard errors are clustered at the city level; tracts are weighted by population size (25-55). Source: Decennial censuses and the American Community Survey, restricted use data.

Table 7: Effects of full-time skilled workers on housing values – IV results

	(1)	(2)	(3)	(4)	(5)
	Dependent Variable: House price ('000) 1980$				
	A. $FT(40, BA+)$				
FT	2.007*	1.71	4.341***	5.026***	3.429**
	[1.201]	[1.363]	[1.215]	[1.049]	[1.508]
$FT \times dist$				-0.194***	-0.401**
				[0.0185]	[0.166]
K-P LM test (p)	0.00615	0.0353	0.00704	0.0024	0.03
C-D $Wald$ stat.	$77.35^{(b5,s10)}$	$32.45^{(b5,s10)}$	$53.9^{(b10)}$	$76.86^{(b5,s10)}$	$12.49^{(b5,s15)}$
K-P $Wald$ stat.	$20^{(b5,s10)}$	$6.007^{(b30)}$	$10.82^{(b10)}$	$18.99^{(b5,s10)}$	3.023
Overid. test (p)	0.0456	0.105	.	0.228	0.29
	B. $FT(40, MA+)$				
FT	3.212	4.595	9.765***	11.11***	5.943
	[2.605]	[3.232]	[2.759]	[2.408]	[4.049]
$FT \times dist$				-0.499***	-0.666**
				[0.0541]	[0.320]
K-P LM test (p)	0.00438	0.0233	0.0053	0.0018	0.0589
C-D $Wald$ stat.	$63.02^{(b5,s10)}$	$20.08^{(b5,s10)}$	$38.88^{(b10)}$	$62.22^{(b5,s10)}$	$9.431^{(b5,s15)}$
K-P $Wald$ stat.	$30.01^{(b5,s10)}$	4.68	$12.92^{(b10)}$	$20.62^{(b5,s10)}$	1.54
Overid. test (p)	0.0589	0.149	.	0.195	0.219
Fixed effects:					
City-Year	✓	✓	✓	✓	✓
City-Distance	✓	✓	✓	✓	✓
Distance-Year		✓	✓		✓
Instruments:					
$Z \times (d1, d2, d3)$	✓	✓		✓	✓
$Z \times d1$			✓		

Notes on separate page.

Notes to Table 7.

All specifications include metro-year metro-distance and distance-year fixed effects.

Regressions 4-5 include continuous distance control, $dist$.

Z is the Bartik demand shifter, see Equation 4, also Table A8. $dist$ is distance in miles from the CBD, $d1, d2$, and $d3$ indicate distance intervals 0-3, 3-10, 10-20 miles from the CBD, respectively.

The unit of observation is a tract and each regression has 65-thousand tract-years.

Significance levels: *** – 0.01; ** – 0.05; * – 0.1. Standard errors are clustered at the city level; tracts are weighted by population size (25-55). Source: Decennial censuses and the American Community Survey, restricted use data.

K-P LM test (p) corresponds to the p-value of the Kleinbergen-Paap LM test. The null hypothesis is that the structural equation is under identified (i.e., the rank condition fails).

C-D $Wald$ stat and K-P $Wald$ statistics are the Cragg-Donald and Kleibergen-Paap Wald statistics for testing weak identification. In both cases, the critical values are the Stock and Yogo [2005] critical values initially tabulated for the C-D $Wald$ stat, see Table 8. We follow Baum [2007] and also apply the Stock and Yogo critical values to the K-P $Wald$ stat (critical values for the K-P $Wald$ stat do not exist). In each case, we specify whether the test statistics rejects the null hypothesis (at the 5% level) that the bias of of the IV estimates exceeds the OLS bias by 5, 10, 20 and 30 percent (b5, b10, b20, b30), and whether test statistics rejects the null hypothesis (at the 5% level) that the size of the test is greater than 10, 15, 20 and 25 percent (s20, s15, s20, s25). C-D $Wald$ stat and K-P $Wald$ statistics reduce to the the standard non-robust and heteroscedasticity robust first-stage F-statistics, respectively. The critical values for the relative bias test cannot be computed for the case of 2 endogenous and 3 instruments and we use the more conservative critical values for the case of 2 endogenous and 4 instruments, see Stock and Yogo [2005] and Table 8.

Overid. test (p) corresponds to the p-value of the test of the overidentifying restrictions. The null hypothesis is that the instruments are valid instruments.

Source: Decennial censuses and the American Community Survey, restricted use data.

Table 8: Threshold values for Cragg-Donald and Kleibergen-Paap $Wald$ statistics

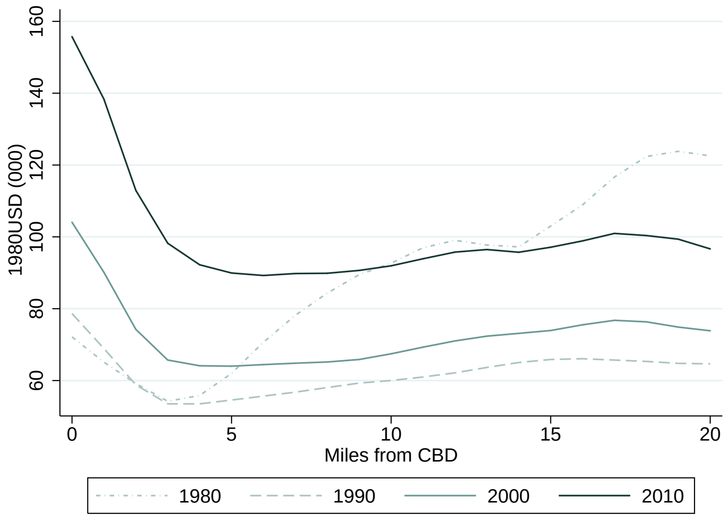
	(1)	(2)
Number of variables:		
Endogenous	1	2
Exogenous	3	4^a
Stock-Yogo 2SLS Bias		
0.05	13.91	11.04
0.10	9.08	7.56
0.20	6.46	5.57
0.30	5.39	4.73
Stock-Yogo 2SLS Size		
0.10	22.30	13.43
0.15	12.83	8.18
0.20	9.54	6.40
0.25	7.80	5.45

^{a} – used for our case of 2 endogenous and 3 exogenous (more conservative).
Source: Stock and Yogo [2005, table 5.1 and 5.2].

Appendix

Figures

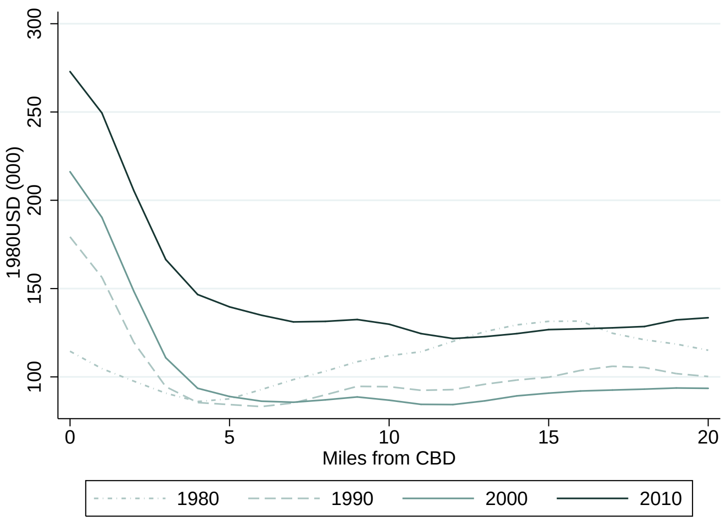
Figure A1: Home prices by distance from the CBD, cities that lost population



Notes: The figure shows the median price (1980$) for owner-occupied, 2-3 bedroom, one-family homes in our top-20 US cities, by distance from the CBD. See the Appendix for further details on variable and sample construction, especially Table A7. 20 miles includes 20-35 miles.

Source: Decennial censuses and the American Community Survey, restricted use data.

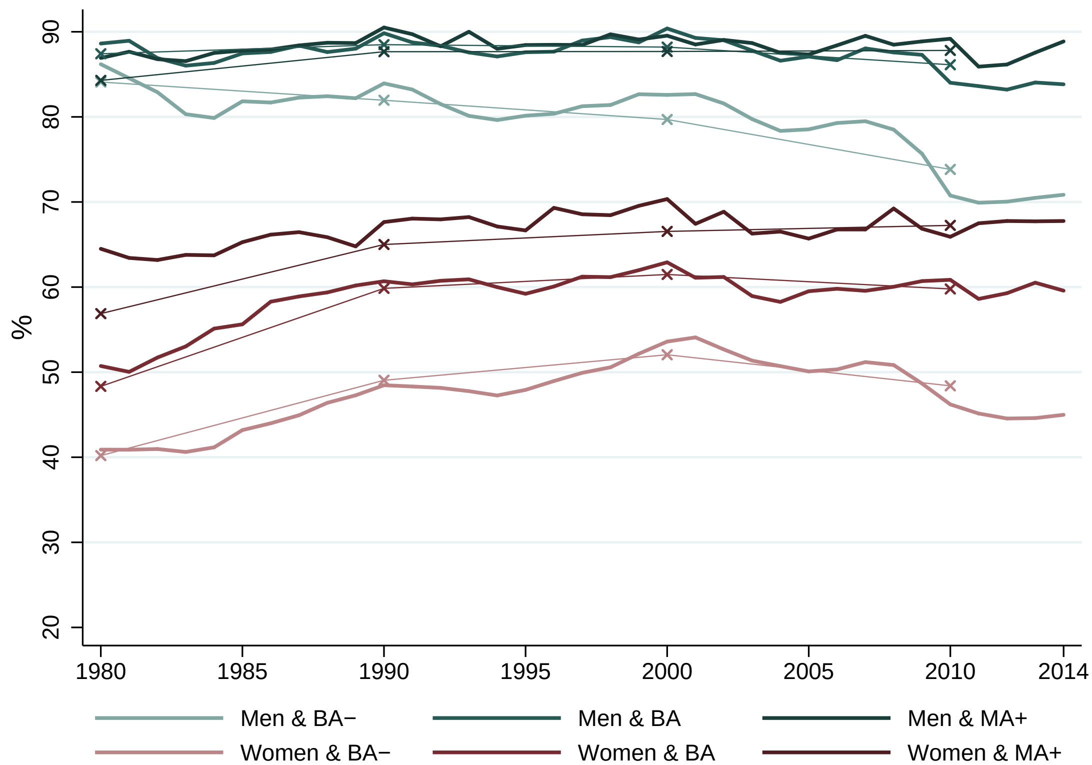
Figure A2: Home prices by distance from the CBD, cities that gained population



Notes: The figure shows the median price (1980$) for owner-occupied, 2-3 bedroom, one-family homes in our top-20 US cities, by distance from the CBD. See the Appendix for further details on variable and sample construction, especially Table A7. 20 miles includes 20-35 miles.

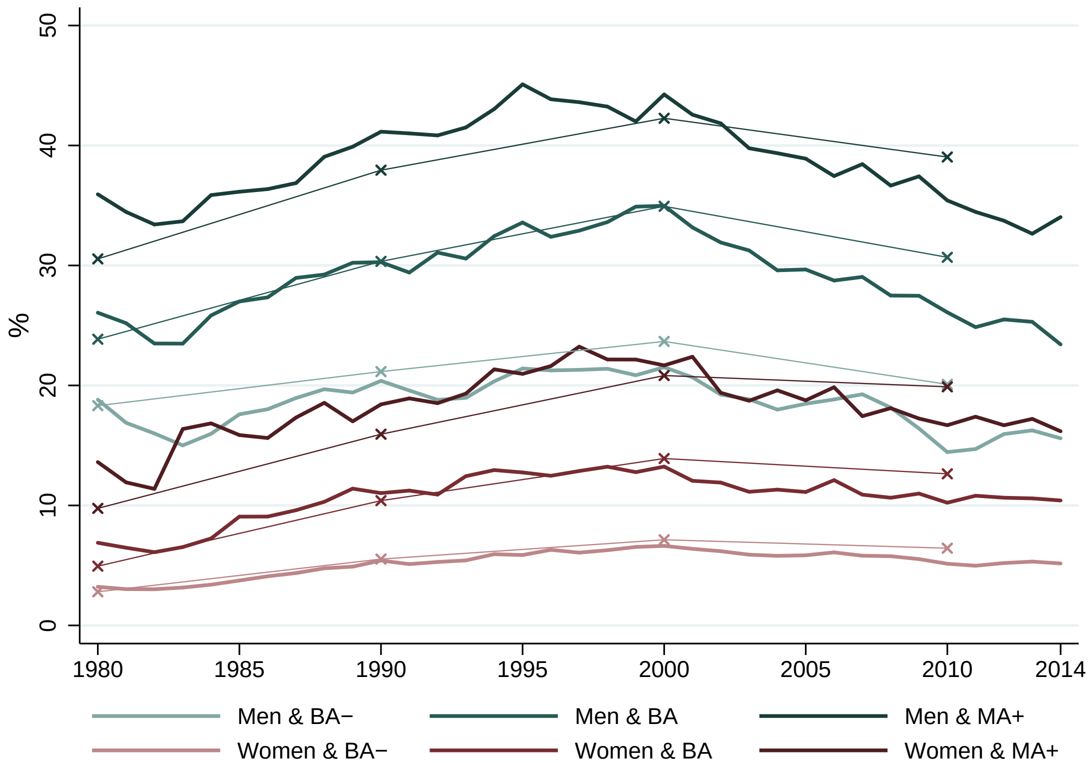
Source: Decennial censuses and the American Community Survey, restricted use data.

Figure A3: Full time (40+h/week)



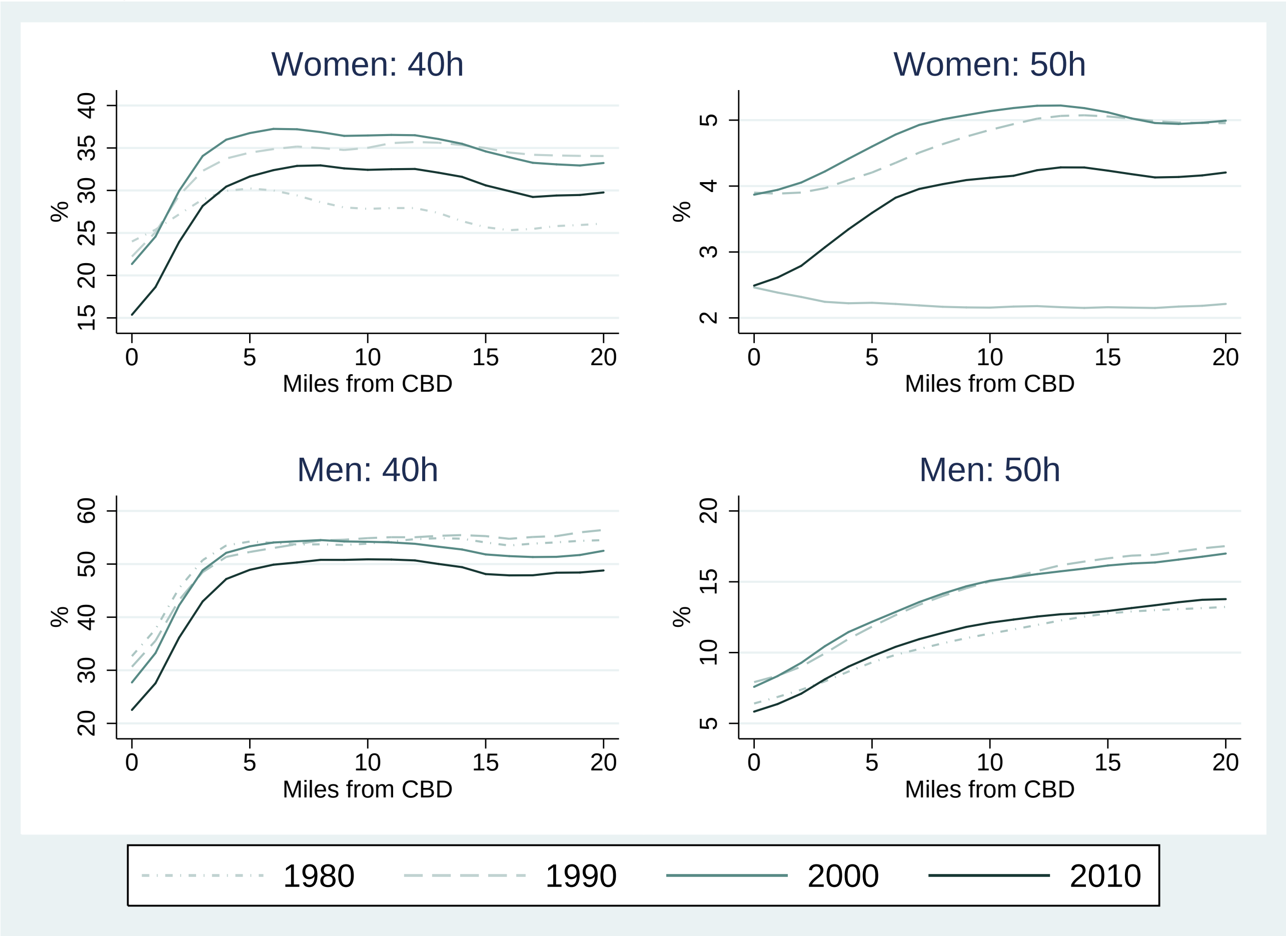
Note: Men and women ages 25-55.
Sources: Decennial data: Decennial censuses, integrated public use micro data series (IPUMS). Annual data: The Current Population Surveys (CPS).

Figure A4: Full time (50+h/week)



Note: Men and women ages 25-55.
Sources: Decennial data: Decennial censuses, integrated public use micro data series (IPUMS).
Annual data: The Current Population Surveys (CPS).

Figure A5: % adults 25-55, unskilled and full time, by distance from the CBD



Notes: 40h(50h) denotes working 40(50) hours or more per week.
Source: Decennial censuses and the American Community Survey, restricted use data.

Tables

Table A1: The Effects of Demand Shock on Housing Values ('000) 1980$, logged

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Dependent Variable: House price ('000) 1980$, Logged								
Z	1.995	1.212							
	[1.585]	[1.622]							
$Z\times$									
$d1$		4.988***	5.031***	3.618***	-1.148	-2.363**			
		[1.157]	[1.172]	[0.581]	[1.438]	[1.009]			
$d2$		2.442***	2.588***	1.798***	1.386				
		[0.605]	[0.602]	[0.529]	[1.501]				
$d3$		0.626***	0.682***	0.720***	1.725*				
		[0.188]	[0.182]	[0.259]	[0.860]				
$Z\times$									
$dist$							-0.532***	-0.335***	-0.246**
							[0.122]	[0.0506]	[0.0833]
$dist^2$							0.0116***	0.00703***	0.00526**
							[0.00270]	[0.00119]	[0.00144
R^2	0.479	0.498	0.528	0.591	0.592	0.592	0.528	0.592	0.593
Fixed effects:									
City	✓	✓							
Year	✓	✓							
City-Year			✓	✓	✓	✓	✓	✓	✓
City-Distance				✓	✓	✓		✓	✓
Distance-Year					✓	✓			✓

Notes, see Table 2.

Table A2: Effects of Bartik-type demand shock on full-time skilled workers

	(1)	(2)	(3)	(4)	(5)
	Dependent Variable: $FT(50, BA+)$				
Z	11.73				
	[8.483]				
$Z\times$					
$d1$		54.97***	35.51**	103.3**	95.50**
		[11.44]	[14.73]	[44.69]	[42.18]
$d2$		8.181	-14.00***	25.65*	
		[7.638]	[3.863]	[14.84]	
$d3$		2.720	-8.558**	-9.807	
		[7.520]	[4.119]	[13.34]	
R^2	0.145	0.167	0.294	0.296	0.296
	$FT(50, MA+)$				
Z	8.160***				
	[1.981]				
$d1$		29.22***	16.79***	43.35**	40.07**
		[4.266]	[5.363]	[17.56]	[17.98]
$d2$		6.175	-6.297***	10.76	
		[5.229]	[2.014]	[7.386]	
$d3$		3.229	-3.270	-4.061	
		[4.468]	[2.224]	[6.950]	
R^2	0.128	0.147	0.253	0.255	0.254
Fixed effects:					
city	✓				
year	✓				
city-year		✓	✓	✓	✓
city-distance			✓	✓	✓
distance-year				✓	✓

Notes, see Table 3.

Table A3: The relationship between full-time skilled workers and housing prices

	(1)	(2)	(3)	(4)
	$FT(50, BA+)$			
FT	4.003***	3.995***	4.320***	3.964***
	[0.371]	[0.371]	[0.325]	[0.322]
$FT \times dist$			-0.0260**	0.00227
			[0.0124]	[0.0118]
R^2	0.488	0.494	0.488	0.494
	$FT(50, MA+)$			
FT	6.732***	6.708***	6.740***	6.210***
	[0.651]	[0.654]	[0.625]	[0.587]
$FT \times dist$			-0.00124	0.0422
			[0.0320]	[0.0283]
R^2	0.480	0.486	0.480	0.486
Fixed effects:				
City-Year	✓	✓	✓	✓
City-Distance	✓	✓	✓	✓
Distance-Year		✓		✓

Notes, see Table 5.

Table A4: Effects of full-time skilled workers on housing values – IV results

	(1)	(2)	(3)	(4)	(5)
	Dependent Variable: House price ('000) 1980$				
	$FT(50, BA+)$				
FT	6.017***	4.328***	5.882***	7.067***	6.887***
	[0.889]	[1.325]	[1.047]	[0.801]	[2.613]
$FT \times dist$				-0.401***	-1.483
				[0.0430]	[1.136]
K-P LM test (p)	0.0163	0.0174	0.00521	0.00677	0.177
C-D $Wald$ stat.	169.4	53	121.8	147.9	2.511
K-P $Wald$ stat.	7.615	4.755	5.17	8.768	1.982
Overid. test (p)	0.0299	0.405	.	0.328	0.91
	$FT(50, MA+)$				
FT	13.15***	10.34***	14.02***	15.28***	10.37**
	[1.973]	[3.234]	[2.421]	[1.787]	[5.090]
$FT \times dist$				-0.915***	-2.401
				[0.107]	[2.362]
K-P LM test (p)	0.0164	0.0142	0.00437	0.0025	0.199
C-D $Wald$ stat.	111.2	28.59	65.86	96.59	2.211
K-P $Wald$ stat.	10.05	4.506	5.008	11.44	0.907
Overid. test (p)	0.0406	0.378	.	0.336	0.463
Fixed effects:					
City-Year	✓	✓	✓	✓	✓
City-Distance	✓	✓	✓	✓	✓
Distance-Year		✓	✓		✓
Instruments:					
$Z \times (d1, d2, d3)$	✓	✓		✓	✓
$Z \times d1$			✓		

Notes, see Table 7.

Table A5: Effects of full-time skilled workers on housing values – IV results, robustness

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Dependent Variable: House price ('000) 1980$							
	Sample:							
		Cross Section:						
		Years:		Crime decline:			Population:	
	Panel	1980/1990	2000/2010	High	Low	not NYC	Shrunk	Grew
	$FT(40, BA+)$							
FT	4.132***	5.267	6.339**	3.767***	3.477*	3.402***	4.266***	4.473***
	[1.407]	[3.768]	[2.599]	[0.793]	[1.943]	[0.671]	[1.379]	[1.647]
K-P LM test (p)	0.0037	0.0444	0.146	0.128	0.0337	0.0496	0.172	0.017
C-D $Wald$ stat.	436.7	6.407	6.727	13.13	40.27	36.78	11.37	43.02
K-P LM test (p)	10.23	12.68	9.509	22.64	22.84	13.03	23.63	31.48
	$FT(40, MA+)$							
FT	9.750***	8.132	8.083***	7.075***	8.704*	7.570***	8.175***	11.39***
	[2.687]	[5.489]	[2.142]	[2.258]	[4.796]	[1.612]	[2.787]	[4.037]
K-P LM test (p)	0.0028	0.0692	0.0943	0.092	0.0318	0.0349	0.183	0.0112
C-D $Wald$ stat.	240.4	10.27	14.87	13.88	22.91	27.74	10.03	26.71
K-P LM test (p)	8.121	6.568	27.51	11.08	16.78	18.36	27.4	15.52
	$FT(50, BA+)$							
FT	5.306***	5.203*	15.67**	7.124***	4.487***	5.326***	7.154***	5.756***
	[1.182]	[2.977]	[7.663]	[1.345]	[1.572]	[1.197]	[1.622]	[1.145]
K-P LM test (p)	0.00436	0.0212	0.132	0.141	0.0193	0.0542	0.114	0.00663
C-D $Wald$ stat.	720.1	35.13	4.338	16.2	94.37	65.25	17.15	106.3
K-P LM test (p)	5.354	8.844	6.511	22.75	6.095	8.368	13.83	9.061
	$FT(50, MA+)$							
FT	12.69***	8.600*	19.72***	15.77***	10.92***	12.72***	15.65***	14.55***
	[2.379]	[4.846]	[5.624]	[4.675]	[3.563]	[2.897]	[3.431]	[2.749]
K-P LM test (p)	0.00548	0.0278	0.0862	0.0993	0.0183	0.0399	0.102	0.00676
C-D $Wald$ stat.	347.8	37.95	8.411	10.14	48.88	35.46	9.747	56.16
K-P LM test (p)	4.376	7.545	20.72	11.22	5.489	8.8	12.24	7.126

The instrument is $Z \times d1$, corresponding to column 3, Table 7.
For cities in columns 4 and 5, see Appendix Table A6.
For cities in columns 7 and 8, see Appendix Table A7.
All specifications include metro-year metro-distance and distance-year fixed effects.
Z is the Bartik demand shifter, see Equation 4, also Table A8. $d1, d2$, and $d3$ indicate distance 0-3, 3-10, 10-20 miles from the CBD, respectively.
The unit of observation is a tract and sample sizes are as follows: column 1: 48 thousand; columns 2-5, 7-8: about 65/2 thousand; column 6: 53 thousand tract-years.
Significance levels: *** – 0.01; ** – 0.05; * – 0.1. Standard errors are clustered at the city level; tracts are weighted by population size (25-55). Source: Decennial censuses and the American Community Survey, restricted use data.
See Table 7 for further notes.

Table A6: Change in Violent Crime 1986-2012

High Crime Reduction Cities	
New Orleans	-.64
New York City	-.60
Boston	-.55
Los Angeles County	-.54
Detroit	-.42
Baltimore City	-.41
Dallas	-.41
San Francisco	-.39
Low Crime Reduction Cities	
St. Louis	-.34
Jacksonville	-.28
City Of Fort Worth	-.28
Washington Metropolitan	-.26
San Diego County Sheriff	-.18
El Paso County Sheriff	-.18
Cleveland	-.17
San Jose	.02
Philadelphia	.10
Columbus*	.18
Memphis	.18
Phoenix	.25
San Antonio	.28
Houston	.31
Austin	.44
Milwaukee	.91
Indianapolis	1.15
Chicago	n.a.
Charlotte	n.a

* The entry for Columbus is for the period 1986-2011.
Violent crimes include murder, rape, robbery, aggravated assault. For a detailed description, see `http://www.ucrdatatool.gov/offenses.cfm`.
Source: Uniform Crime Report `http://www.ucrdatatool.gov/Search/Crime/Local/TrendsInOneVarLarge.cfm`

Table A7: Population Change

City	Population 1970	Population 2010	Change	% Change
		Shrunk		
Detroit	1,511,482	713,777	-797,705	-53
St. Louis	622,236	319,294	-302,942	-49
Cleveland	750,903	396,815	-354,088	-47
New Orleans	593,471	343,829	-249,642	-42
Baltimore	905,759	620,961	-284,798	-31
Philadelphia	1,948,609	1,526,006	-422,603	-22
DC	756,510	601,723	-154,787	-20
Chicago	3,366,957	2,695,598	-671,359	-20
Milwaukee	717,099	594,833	-122,266	-17
Boston	641,071	617,594	-23,477	-4
Sum	11,814,097	8,430,430	-3,383,667	-29
		Grew		
New York	7,894,862	8,175,133	280,271	4
Memphis	623,530	646,889	23,359	4
Indianapolis	744,624	820,445	75,821	10
SF	715,674	805,235	89,561	13
LA	2,816,061	3,792,621	976,560	35
Columbus	539,677	787,033	247,356	46
Jacksonville	528,865	821,784	292,919	55
Dallas-FW	1,237,877	1,939,012	701,135	57
Houston	1,232,802	2,100,263	867,461	70
San Diego	696,769	1,307,402	610,633	88
El Paso	322,261	649,121	326,860	101
San Antonio	654,153	1,327,407	673,254	103
San Jose	445,779	945,942	500,163	112
Phoenix	581,562	1,445,632	864,070	149
Charlotte	241,178	731,424	490,246	203
Austin	251,808	790,390	538,582	214
Sum	19,527,482	27,085,733	7,558,251	39

Source: US Census.

Bartik

We group industries into 41 categories using the 1990 industry classification available in IPUMS (see IPUMS website or Edlund et al. [2015]. In the preliminary analysis we also used a more aggregate grouping into seven industries, the results were very similar, but we favor the more disaggregate grouping because of the reduction in within-group industry heterogeneity.

Table A8: Bartik, Base Year 1970

City	1980	1990	2000	2010	Central Business District (CBD)
Austin	0.169	0.259	0.320	0.350	Texas Capitol
Baltimore	0.110	0.169	0.206	0.223	W. Lexington × Park Ave.
Boston	0.144	0.226	0.277	0.298	South Station
Charlotte	0.102	0.162	0.192	0.206	Charlotte Convention Center
Chicago	0.110	0.175	0.214	0.229	LaSalle × W. Congress Parkway
Cleveland	0.102	0.162	0.196	0.212	Soldiers' and Sailors' Monument
Columbus	0.126	0.197	0.242	0.262	E. Long Street × Route 3
Dallas	0.122	0.196	0.232	0.251	Dallas Convention center
Detroit	0.090	0.145	0.171	0.186	Grand Circus Park
El Paso	0.112	0.170	0.211	0.230	El Paso Art Institute
Fort Worth	0.122	0.196	0.232	0.251	Fort Worth Convention Center
Houston	0.137	0.209	0.243	0.266	Houston Center
Indianapolis	0.093	0.147	0.177	0.191	Monument Circle
Jacksonville	0.094	0.148	0.178	0.194	Bank of America Tower
Los Angeles	0.126	0.200	0.242	0.260	Pershing Square
Memphis	0.091	0.144	0.176	0.190	Beale St. × Riverside Drive
Milwaukee	0.102	0.159	0.192	0.207	Milwaukee County Court House
New Orleans	0.112	0.169	0.196	0.216	New Orleans Morial Convention Center
New York	0.136	0.217	0.266	0.286	Rockefeller Center
Philadelphia	0.105	0.165	0.202	0.218	City Hall
Phoenix	0.116	0.183	0.221	0.237	Phoenix Convention Center
Saint Louis	0.103	0.163	0.197	0.213	Federal Reserve
San Antonio	0.089	0.138	0.166	0.180	Tower of the Americas
San Diego	0.125	0.196	0.240	0.259	Horton Plaza
San Francisco	0.172	0.273	0.332	0.362	Transamerica Pyramid
San Jose	0.163	0.253	0.312	0.330	1 Infinity Loop (Apple Inc. headquarters)
Washington D.C.	0.229	0.344	0.426	0.461	White House

Variable construction

PRICE **2-3 Bedroom single-family Home** The decennial censuses and the ACS ask the owner of owner-occupied single-family homes the estimated value of the value of their home. While self-reported assessments of values, we will refer to them as housing prices.

In order to obtain numbers that are close to market prices, we restrict the sample to those who moved in within the last ten years, on the assumption that homes that owners of more recently bought and sold units would be more knowledgeable about price developments than those with longer tenure.

To obtain a price that refers to comparable units while preserving sample size, we focus on two or three bedroom single-family homes. Housing prices are given in intervals and the bracket values vary across the years. Therefore, we focus on the median bracket value. For tracts where the median bracket is the top code, we assign the dollar value that would be the mean if the top bracket had had the same range as the penultimate bracket. For instance, if the penultimate bracket ranged from 800 thousand to 1 million, and 1 million and above were the top bracket, we would give houses in the top bracket a 1.1 million dollar valuation. We chose this rule because it is conservative and if anything result in an underestimate of the price increases close to the CBD.

We focus on the median house price in the tract. Top coding is our reason for focusing on the median rather than a more selective percentile.

In our main specification, we impute a value that is the same distance from the top-code threshold as the immediately preceding midpoint value. For instance, if the top bracket is 800-1000, and values above 1000 are top coded, we assign the value 1100 to the top code. This method is conservative if the housing price distribution, like the wealth and income distributions, is right skewed.

We also tried alternative top codings, including simply imputing the threshold value. Our qualitative results were not sensitive to these variations.

For the study period 1980-2010, our measure shows a 30 percent increase in constant dollars, a rise largely inline with the Case-Shiller national index's rise of 26 percent. The Case-Shiller national index went from 43.44 to 145.0, and the CPI from 100 to 264, yielding a constant dollar housing price increase of 26 percent ($=\frac{145}{43.44} \times \frac{100}{264} - 1$).

Another benchmark is offered by the Census Bureau's constant price index for new-family homes sold rose from \$72 to \$272 thousand, current dollars. In constant dollars, the increase was 30 percent ($=\frac{261}{76} \times \frac{100}{264} - 1$). `https://www.census.gov/const/www/constpriceindex_excel.html`

We use the Consumer Price Index (CPI) to deflate housing prices. A theoretical concern is that housing accounts for some 40 percent of the CPI and therefore a price index that excluded housing would be preferable, for instance the food price index. Conveniently, the food price index moved very closely with the CPI and on those grounds we use the CPI despite its theoretical shortcomings.

Center point, Central Business District (CBD) For each city we identified the center with the help of Google maps. All cities had a clear central area identifiable from the convergence of roads, the presence of a main railway station, clusters of hotels with the national chain name prefixed by "down town" and a concentration of signature institutions and monuments. We used the thus identified area to designate a city center, with one exception. For San Jose, we placed downtown in Silicon Valley.

The only city with more than one clear center was New York City, where both midtown and downtown can claim that title. We picked the midtown center but locating the center downtown resulted in similar results. Because of this ambiguity, in a robustness test we exclude the New York metropolitan area and results are robust to this exclusion (Table A5, column 3).

Within each center we picked a center point, a salient building or monument, and obtained its latitude and longitude from iTouchMap.com. For instance, for Washington DC, the CBD is given by the White House and for San Jose, Apple Inc. Headquarters. While clearly there are alternative points, but most contenders would be within a mile or two of the points picked, listed in Table A8.

Distance to the CBD (*dist*) From tract shape files, we have generated latitude and longitude for the (population weighted) centroid of the tract, allowing us to calculate the distance between a tract and the CBD. We restrict our sample to tracts that are within 35 miles of the CBD.

In the preliminary analysis, we found our variables of interest to exhibit a pronounced j-shape with respect to distance from the CBD, the minimum located somewhere in the 3-7 mile range. Therefore we grouped distance from the CBD as follows:

d1 0-3 miles

d2 3-10 miles

d3 10-20 miles

d4 20-35 miles, reference category.

FT **Full Time** $FT(h, e)$ denotes the fraction of adults 25-55 who worked more that $h, h = 40, 50$ hours per week and had education $e, e = BA+, MA+$.

Z **Metropolitan Area Demand Shifter for Skilled Workers** See description in Section 2.2

IV.1 Panel data set construction

We use US2010 cross-walk files to create a tract-level panel data set, where for each tract in 2010 we construct its equivalent in previous years using cross-walk files from `http://www.s4.brown.edu/us2010/Researcher/Bridging.htm`. These files provide a mapping of tracts in a census year and 2010, as well as weights. For example, if there were a new tract B in 2010 that was the result of combining blocks from year 2000 tracts B1 and B2, then we would create a year 2000 tract B as a weighted average of B1 and B2. Thus, the ability to include tract fixed effects comes at the cost of data quality, and the problem worsens with the number of years to 2010 (more time allows for more changes to tracts). In order to explore the role of race, we are interested in parsing the sample by initial fraction blacks. Therefore, we restrict the sample to tracts for which we have an observation in 1980 and also remove tracts for which we only have one observation. We are left with a sample of about 48 thousand tracts.